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SHIPBUILDING MANAGEMENT
ISSUES AND FUNCTIONS

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SHIPBUILDING MANAGEMENT ISSUES AND FUNCTIONS

by

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//
Bachelor of Science

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A thesis submitted to the faculty of the School of Government,
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University, in partial satisfaction of the requirements
for the degree of Master of Business Administration

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PREFACE

In the early 1960's, the Navy paid approximately \$120,000,000 to have the carrier USS KITTY HAWK built at the lowest contractual bid of a private shipbuilder. It required an additional \$60,000,000 in repair costs immediately following the ship's delivery to the fleet to make it operational. Similarly, the Navy is now paying one-half million to one million dollars each to repair several guided missile destroyers. Since the time interval between the shipbuilder's delivery of the ship to the fleet and the regular shipyard overhaul was relatively equal in all cases, the question arises as to how and why such situations come to be.

This thesis will attempt to explain naval shipbuilding management issues and functions, and deal with the problem of analyzing and interpreting a ship's lifetime building and repair costs. Its purpose is to show the relationship and importance these issues and functions have on a ship's lifetime building and repair costs, and also to show the significance of government policy and decision making in recognizing and maintaining the quality of work performed at the shipbuilding yard. Two questions are discussed: What are the Naval shipbuilding management issues and functions influencing a guided missile destroyer's lifetime building and repair costs? and, Does the quality of work performed at the shipbuilding yard have a major bearing on the repair costs during the life of a ship?

The dollars required for naval shipbuilding are provided by the government. How does planning for financing naval shipbuilding and repair costs relate to the government budget? Chapter I is concerned with shipbuilding management as part of the budget process. It discusses the budget as a tool of shipbuilding management, the shipbuilding budget cycle in the preparation and review stages, and finally the classification of shipbuilding within defense programming.

An adequate information system is essential not only for accountability but also for controlling shipbuilding expenditures. Do present day methods control shipbuilding expenditures? Chapter II describes the present ways in which the Bureau of Ships controls shipbuilding expenditures. A survey is presented on the current use of automatic data-processing in the Bureau of Ships as part of the shipbuilding information system.

The major categories of building and repair costs during a ship's lifetime can be measured and compared. The means of converting dollars input to ship output is highly dependent on the quality of shipbuilding craftsmanship. What policy and statistical decision making implications at the bureau level do these costs have on the quality of shipbuilding craftsmanship? Chapter III discusses the management issue of measuring and comparing building and repair costs and the function of statistical decision making. In dealing with the quality of work performed at a shipbuilding yard, a description of the four major categories of building and repair costs is presented.

An analysis and comparison of these costs and their relationships to the quality of work performed and repair costs is made here.

The output of dollars spent on naval ships is represented in the ship and its crew. The commanding officer can have a powerful influence on the efficient use of a ship and in turn lower repair costs. The importance of this shipboard organization issue is mentioned.

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CHAPTER I

THE BUDGET AND SHIPBUILDING

Naval shipbuilding management¹ is concerned with the Federal Budget as a tool for planning its finances. A study of the shipbuilding budget cycle is presented to show how and by whom it is prepared and reviewed. Further, a classification of the shipbuilding program within Defense Programming describes another aspect of planning for financing naval shipbuilding.

Shipbuilding Budget as a Tool

Burkhead says that the word budget originally meant the money bag or the public purse, which served as a receptacle for the revenue and expenditure of the state. The term came to mean the documents which were contained in the bag--the plans for government finances submitted for the approval of the legislature.²

The budget is an instrument in the shipbuilding management of a government's economy and reflects the relative

¹Management is the science and the art of the direction of an enterprise through planning, organizing, coordinating and controlling of its human and material resources toward the attainment of pre-determined objectives. L. W. Wallace, Top Management Seminar of the U. S. Army Management Engineering Training Agency, October 1961.

²Jesse Burkhead, Government Budgeting (New York: John Wiley & Sons, Inc., 1956), p. 2.

distribution of economic and political factors within a government such as the cost of ships and the shipbuilding budget process.

Wildavsky looks at the budget not only as a document but also as a contract.¹ Congress and the President promise to supply shipbuilding funds under specified conditions, and the Bureau of Ships agrees to utilize them as agreed upon.

A shipbuilding budget in a government sense lacks the market as a guide and the goal of profit for the organization and disciplining of its efficiency of resource allocation and rules for decision-making. However, as Colm has suggested, in terms of the budget principle:

The essence of the budget principle is that the services in this sphere are determined not by profit expectation and the willingness of individuals to spend their money for the purchase of such services, but by decisions reached through political and administrative procedures and based on common social objectives.²

Thus, the government shipbuilding budget is not entirely of the same nature as the business budget.

Shipbuilding Budget Cycle

The complete shipbuilding and conversion cycle as part of the federal spending or budget process includes four main budgetary phases: (1) preparation, (2) authorization, (3) execution, and (4) audit.³ The discussion here is confined to

¹Aaron Wildavsky, The Politics of the Budgetary Process (Boston: Little, Brown and Company, Inc., 1964), p. 1.

²Gerhard Colm, "Why Public Finance?" Essays in Public Finance and Fiscal Policy (New York: Oxford University Press, 1955), p. 9.

³Ibid.

the first two: how shipbuilding expenditure requests are prepared in the executive branch, and how they are then examined and passed upon by Congress.

National security policies (functional classifications), are first approved by the President and provide the broad policy guidance in security considerations. These are transmitted to the Secretary of Defense, to the Joint Chiefs of Staff and to the Secretary of the Navy. The Joint Chiefs of Staff develop supporting military plans (Joint Plans) which list the forces to be provided and the missions and tasks for each command for the fiscal year. The Chief of Naval Operations, in consonance with expressed policy, prepares plans to support Joint Plans and other directives from the Secretary of the Navy and higher authority. This guidance from the Chief of Naval Operations becomes the basis for the formulation of the shipbuilding appropriation.¹

The formulation of the Shipbuilding and Conversion, Navy appropriation originates within the Standing Committee of the Office of the Chief of Naval Operations. Approximately two years prior to the start of a budget year, this Standing Committee formulates a tentative annual plan for ships and revises the five year force structure and financial plan for shipbuilding and conversion. This revision is based on recommendations from the sponsor of the shipbuilding appropriation,

¹U. S., Department of the Navy, Bureau of Ships and Office of the Comptroller. Procurement and Production Program and Shipbuilding and Conversion (December, 1961), p. 4-3.

the Deputy Chief of Naval Operations (Fleet Operations and Readiness). This office is the ultimate user of ships and therefore is presumed to know how many ships and what types are needed to carry out the Navy's mission.

Long-range planning documents, long range requirements, and long range objectives, budgetary guidance and informal cost estimates interrelate to set the stage for initiating the shipbuilding appropriation about 16 months before the budget year.

The guidance received by the technical bureaus from the Chief of Naval Operations is contained in the Navy Annual Program Objectives document. This is sent to the Bureau of Ships for use in preparing the shipbuilding appropriation about 15 months in advance of the budget year. The Program Objective is the annual increment of the projected program objectives (Five Year Force Structure and Financial Planning) adjusted as necessary to reflect the Secretary of Defense's anticipated annual budgetary guidelines. The number, types, and estimated costs of ships for new construction and conversion are listed in the Annual Program Objectives.

The shipbuilding budget preparation culminates at the presidential level in January six months before the start of the fiscal year, after successive reviews by the Bureau of the Budget, the Department of Defense, and the Department of the Navy. It is characterized by a flow-up and flow-back of decisions.

The general time frame of the interplay among the

Bureau of Ships, Bureau of the Budget, and the President (Executive Staff) can be described in six steps. (1) At approximately 16 months before the fiscal year starts, the Bureau of Ships submits formal estimates to the Bureau of the Budget after deliberations between both agencies of seven months or more.

(2) At approximately 13 months before the fiscal year starts, the Bureau of the Budget reviews the budgetary outlook with the Treasury and Economic Advisers and determines recommendations on the Bureau of Ship's shipbuilding formal estimates to the President.

(3) Twelve months before the fiscal year starts, the President with his Executive Staff receives the Bureau of the Budget's recommendations, reviews them, and decides on the dollar amounts shipbuilding will obtain.

(4) Approximately nine months before the fiscal year starts, the Bureau of Ships revises its estimates to conform to the President's decisions after getting his verdict on any Bureau of Ships appeals.

(5) Approximately seven months before the fiscal year starts, the Bureau of the Budget again reviews the economic outlook and shipbuilding policy with the President.

(6) Approximately six months before the fiscal year starts, the President with his Executive Staff makes final revisions and approves the budget message which includes a summary and analysis of the shipbuilding program. In January the President transmits his budget to Congress.

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Once it is presented by the President, the budget has to pass through the legislative branch for final implementation. However, the Congress of the United States does not review the President's shipbuilding policy in its total dimensions. No occasion is provided for an examination of aggregate revenues and expenditures, nor for the interrelation of expenditure programs with the shipbuilding program. The term authorization, which in most governments would embrace both revenue measures and appropriations, in the United States government applies only to the expenditure side of the shipbuilding program.¹

The crux of shipbuilding spending authorizations by Congress lies in the appropriating process. Jurisdiction for committee handling of shipbuilding appropriations matters is in the hands of the two appropriations committees, House and Senate. Both committees are subdivided into 13 subcommittees; one subcommittee deals with the particular parts of the shipbuilding appropriation. The scope of neither the House nor the Senate appropriations sub-committees corresponds exactly with the jurisdiction of the legislative "standing committees" which must first approve the substantive shipbuilding programs before the shipbuilding appropriations committee is called on to review and approve spending requests.

The path of the shipbuilding appropriation proposals during the Congressional review starts in the House Appropriations Committee. The appropriation proposals contained in the

¹Robert W. Schleck, Controlling Federal Expenditures (New York: Tax Foundation, Inc., December 1963), p. 20.

President's budget are divided into part of an individual appropriation bill. After subcommittee decisions have been made, the shipbuilding bill is acted upon by the full appropriations committee and then by the House. After the House version of a shipbuilding appropriation bill reaches the Senate, it is handled in parallel fashion. If the amounts approved by the House and the Senate differ, a conference committee must reconcile the differences. The conference committee is empowered to adopt a final figure between the amounts approved by the House and Senate; the decision is then reported back to the full membership of both houses. Occasionally one body will send the bill back to conference with instructions for further discussion. Ordinarily, however, the original conference decision is accepted as reported.

Normally in the United States government, the authorization of a program by Congress precedes the appropriation of funds for the program. The Department of the Navy and the Bureau of Ships are established by statute and endowed with responsibilities which may be specifically or broadly defined by statute. Where responsibilities are specifically defined, the authorizing statute, in effect, controls program level and appropriation. Where responsibilities are broadly defined, decision-making in the appropriating process is correspondingly broad.¹

¹ Legislation written in specific terms limits the legislative appropriations committee decision making margin and approval of such financial authorization is routine. An example is the agricultural price support programs which are controlled by statutes that prescribe the level of support to be undertaken and authorize the Commodity Credit Corporation

Legislation written in broad terms, which shipbuilding normally fits into, gives the legislature's shipbuilding appropriations committee considerable decision making latitude. Approval of financial shipbuilding authorization is made only after the committee, in effect, fills in the details of the original legislative intent, and these may be very significant details. Once broad term shipbuilding appropriations are in operation, the administrator of the program, the Bureau of Ships, must return to the legislature for an annual review and shipbuilding authorization. The Bureau has had experience in the implementation of the original legislative intent as expressed in the shipbuilding statute and in the shipbuilding authorization. The results of this experience and the Bureau Chief's proposals for its interpretation and modification are reviewed by the shipbuilding appropriation committee. The interrelationship among the original shipbuilding legislation, the subsequent budget authorizations, and the actions and proposals of the Bureau of Ships--this continuous interpretation and reinterpretation of legislative shipbuilding intent--illustrates the continuous overlap of the Bureau of Ships and legislative authority.

The relationship between the basic shipbuilding statutes and the shipbuilding authorization for the Department of Defense and in turn the Shipbuilding and Conversion, Navy Appropriation title is broad. These statutes very seldom specify the number of ship crews to be maintained in any one year, the number of

to make the necessary farm prices at that level. See Jesse Burkhead, Government Budgeting (New York: John Wiley & Sons, Inc., 1956), p. 308.

ships to be floated, or the number of missiles to be kept operative. These decisions are made in large measure by the appropriations committees, after examining the shipbuilding program of the Department of Defense, hearing the testimony of the Bureau of Ships Chief and reviewing the operating experience of the Bureau in the Navy Department, and relating defense shipbuilding expenditures to overall budgetary requests and revenues.

Specific statutes affecting the Shipbuilding and Conversion, Navy Appropriation Title are the Washington and London Naval Limitation Treaties of 1922 and 1930, and the Vinson-Trammell Act of 1938 and 1940. These involve the basic tonnage authorization for naval ships. Also, because of the replacement feature of the latter act, a considerable unobligated warship tonnage authorization today is in excess of two and one-half million tons. Public Law 86-149 requires the Secretary of Defense to submit detailed information in support of authorization requests. Title 10 United States Code, Chapter 633 provides the general authority for the disposal of Navy ships. Title 10 United States Code 7298 gives authorization to the President for conversion and modernization of naval ships after Congressional review.¹

The shipbuilding authorization bill that provides for construction and conversion of naval ships is of the lump-sum dollar type. After presentation of the bill to Congress by the

¹U. S. Department of the Navy, Bureau of Ships and Office of the Comptroller. Procurement and Production Program and Shipbuilding and Conversion. (December, 1961), p. 5-2.

Secretary of Defense, the appropriations committees hold hearings and examine each of the major weapons on each ship for which authorization of appropriations is requested. Characteristics and capabilities of each weapon system on a ship are reviewed in light of the planned utilization within the Defense force program structure. Changes initiated by the committees are reflected in an adjustment of the lump-sum contained in the bill.¹

Classification of Shipbuilding and Defense Programming

The classification of shipbuilding information is essential for defense programming. Shipbuilding budget data on expenditures or appropriations must be organized in such a way that their significance may be understood and comparisons facilitated. Shipbuilding classification is a means of observation and gives information on shipbuilding operations and the forms and structure essential for analysis and inference. It is the structural key to conscious and rational government decisions. The search for an ideal single shipbuilding classification for the budget for different classes of ships appears to be a mistaken and fruitless search.

Shipbuilding activity is conducted by the Defense Department and the Department of the Navy, chiefly through the Bureau of Ships. Shipbuilding program authorizations to the Department of the Navy and shipbuilding appropriations to conduct these programs, are made by the legislature. Shipbuild-

¹Ibid., p. 5-7.

ing programs must be administered legally, that is, in conformity with constitutional and legislative requirements. The program is the operational center of the Department of Defense and shipbuilding activity.

To satisfy legislative analysis of shipbuilding programs, classification has been broadened to three categories: functions, organizations, and objects. A functional shipbuilding classification is concerned primarily with governmental expenditures and is designed to facilitate shipbuilding program formulation at the chief executive's level and the level of legislative review. The functional shipbuilding classification sets forth, on the expenditure side, the broad shipbuilding programs which the government is conducting, in terms of the national interest being served, as for example, national security, international affairs, commerce, etc.

The organizational shipbuilding classification refers to the units of government who plan and execute shipbuilding programs. The major budget summary accounts are best presented on a functional basis, which cuts across agency and departmental lines, but the second most important basis for summary account presentation is an organizational shipbuilding classification. A shipbuilding appropriation measure authorizes the Bureau of Ships to incur obligations or to make disbursements for specified purposes. An organizational shipbuilding classification underlines the ultimate legal authority which must be extended by the legislature, as for example, the Department of the Navy, Bureau of Ships, Department of Defense, etc.

The object classification centers attention on the accounting aspect of shipbuilding operations in terms of items purchased. It serves to establish a tight control over expenditures and limits the discretion of government officials. This classification is frequently called the "line-item" budget. Examples are the Department of the Navy schedule for personnel, operation and maintenance, procurement (of which shipbuilding and conversion Navy is a part), research, and military construction.

As government grew, and especially the Department of Defense and the Bureau of Ships, it became apparent to those at the upper decision levels that a gap was developing between shipbuilding objectives and government purchases being accounted for. The original shipbuilding program concept as the operational center of government activity was being lost between the extremes of function shipbuilding classification and organizational, object shipbuilding classification. The term performance budgeting was introduced to refer not to the means of accomplishment but to the accomplishment itself. A performance budget mainly serves shipbuilding management purposes at and below the departmental level, although it may also provide useful information for review. Performance shipbuilding classification seeks to measure the cost and accomplishment of detailed activities, and by so doing improve the implementation of shipbuilding programs.

Shipbuilding budget programs are forward-looking projections of the economic and social and political policies

of a government. Shipbuilding performance is based on the past--on the record of prior accomplishment. In the preparation of shipbuilding estimates, shipbuilding program determinations precede and set the framework in which the measurement of shipbuilding performance can be undertaken. A shipbuilding program budget is useful for review and decision-making at and above the departmental level.

Shipbuilding programs are included in the nine defense programs. These represent similar military missions of the services in four broad functional classifications: all out war (Program I), continental defense (Program II), conventional war (Program III), and transportation of combat forces overseas (Program IV). The other five programs support these four basic missions. The nine programs are:¹

- I. Strategic Retaliatory Forces
- II. Continental Air and Missile Defense Forces
- III. General Purpose Forces
- IV. Airlift and Sealift Forces
- V. Reserve and Guard Forces
- VI. Research and Development
- VII. General Support
- VIII. Civil Defense
- IX. Military Assistance Program

Shipbuilding dollars are channeled from the nine programs. For example, major programs are subdivided into program elements. The program element is the smallest unit of military output controlled at the Department of Defense level. It is an integrated combination of men, equipment, and facilities which together constitute an identifiable military

¹U. S. Department of the Navy, Office of the Chief of Naval Operations. The Navy Programming Manual. Publication No. OPNAV 90P-1 (September, 1964), p. 1-3-2.

capability or support activity. The Fleet Ballistic Missile System, Attack Carriers (Forrestal Class) and recruit training Navy are examples of program elements. All program elements taken together constitute the complete defense establishment.

Shipbuilding dollars are programmed ahead then as part of each program element, which is projected ahead, in terms of its cost, for five years and force structure for eight years under the Five Year Force Structure and Financial Program (FYFS & FP). The FYFS&FP is the foundation of the Department of Defense's inputs to military outputs or programs and breaks costs down into three groups: Research and Development, Investment, and Operating. The bridge between planning and accounting budgeting is provided by the further breakdown of costs for each program element into the regular budget format (appropriation titles).

The approved program of which shipbuilding is a part is published in the form of the Five Year Force Structure and Financial Plan Book and establishes the existing force structure. Changes in force structure (e.g., the number of destroyers in the fleets) under which the appropriation title of Shipbuilding and Conversion, Navy applies, are decided in a change proposal submitted to the Secretary of Defense. Obtaining the shipbuilding program for any given year in the Department of Defense consists basically of lifting out that year's increment in the approved force structure, with costs broken down by the traditional budget titles, refining the costs on the basis of more recent information, and casting these updated costs into the

budget format. The importance of this program arrangement as a tool of shipbuilding management for top level decision making appears firmly established. A fundamental dichotomy between the usefulness of the program arrangement at at different decision making levels in relation to shipbuilding planning and shipbuilding accounting appears to exist in the sense that a clear line cannot be drawn between what decisions are program decisions and what decisions are operating decisions.

In a technical sense, the defense shipbuilding appropriation is an expenditure budget or an expenditure-appropriation budget, but it is not an income-expenditure shipbuilding bill. The Bureau of Ships programs on the assumption that revenues will be available to cover its estimated expenditures; it is not directly concerned with how these revenues are to be provided. This latter is the concern of other executive central offices and Congress.

The Shipbuilding and Conversion, Navy appropriation is included in the procurement appropriations for the Department of the Navy. It includes all Naval new ship construction and conversion, on an annual basis. Funds are requested for a list of ships in a given fiscal year and the ships remain assigned to that fiscal year throughout the construction or conversion period. Consequently, the funds appropriated in one given year will extend over a period of several years.¹

¹U. S. Department of the Navy, Bureau of Ships and Office of the Comptroller. Procurement and Production Program and Shipbuilding and Conversion, p. 3-2.

The full funding characteristic of the Shipbuilding, Conversion Navy appropriation states that a ship may not be awarded to a contractor unless there are sufficient funds available to complete it. It follows that budget estimates must be developed and presented on a full-funding basis.

The end-cost characteristic of the Shipbuilding Conversion Navy appropriation requires that in the initial estimates on any ship a complete price be requested. This is to eliminate having to return to Congress for additional obligational authority due to cost overruns. These initial estimates include an allowance (projected growth) for future wage and material increases (escalation), for future changes in ship characteristics, and changes within the scope of the characteristics.

Complete ships (end items) are the basic building block of the appropriation and all costs budgeted for are directly related to individual ships. Estimates are developed on a cost basis. The budget is presented to Congress, however, on the basis of new obligational authority required; i.e. any assets available are netted out in determining obligational authority required.

The Shipbuilding Conversion Navy appropriation as submitted in the budget document includes estimates covering the Bureau of Ships, Bureau of Weapons and the Special Projects Office. After enactment of the appropriation, apportionments are made at the appropriation level by the Bureau of the Budget and funds are allocated at the budget activity level through

the Navy Comptroller to the Bureau of Ships. Allocations representing Bureau of Naval Weapons and Special Projects responsibilities are immediately suballocated to the Bureau of Weapons, which transfers to Special Projects by means of a letter of authority the entire obligation authority received from the Bureau of Ships for the Ballistic Missile System, the program element under the Department of Defense Program Concept.

Within the Bureau of Ships, the Shipbuilding Conversion Navy is broken down into the project level. This level is identified as to the ship type within the fiscal year of approval. The subproject identifies a ship or group of sister ships being constructed under one contract or project order.

The relationship between the Shipbuilding Conversion Navy appropriation title and the Department of Defense Program Concept is shown in Table 1 on page 18.

The need for a shipbuilding budget should be viewed from the approach that there can be no separation of economics from politics in shipbuilding decision-making. The inter-mixing of economics and politics between legislative and executive branches of government and within each branch all bear weight on the need for a shipbuilding budget in the government sense.

Summary

In summary, the problem of planning for financing naval shipbuilding is in essence a shipbuilding managerial problem of government budgeting, the answer to which involves many areas of consideration. Not only does it involve the phases and factors of the shipbuilding budget process, but also

TABLE 1

SHIPBUILDING CONVERSION NAVY APPROPRIATION COMPARED
TO TOTAL NAVY DOLLARS AND DEFENSE PROGRAMFiscal Year 1965 (In Millions)^a

Program	Total NAVY	SCN
I Strategic Retaliatory Forces	\$ 1,028.6	69.9
II Continental Air & Missile Defense	138.4	--
III General Purpose Forces	9,073.7	1804.1
IV Airlift and Sealift Forces	46.0	8.4
V Reserve and Guard Forces	396.0	--
VI Research and Development	1,128.0	4.6
VII General Support	<u>3,056.3</u>	<u>24.0</u>
Sub-total	\$14,867.1	1911.0
Reimbursable Program	906.7	222.0
Other	<u>96.5</u>	<u>--</u>
Total FY 1965 Program	\$15,870.3	2133.0
<u>Financing</u>		
Deduct:		
FY 1965 reimbursable	936.3	222.0
Amounts reprogramed to (-) or from (+) other programs	479.8	49.5
Other	71.6	--
Add:		
Unprogrammed balances year end	<u>395.4</u>	<u>68.6</u>
New obligational authority - Total	<u>\$14,506.9</u>	<u>\$1930.1</u>

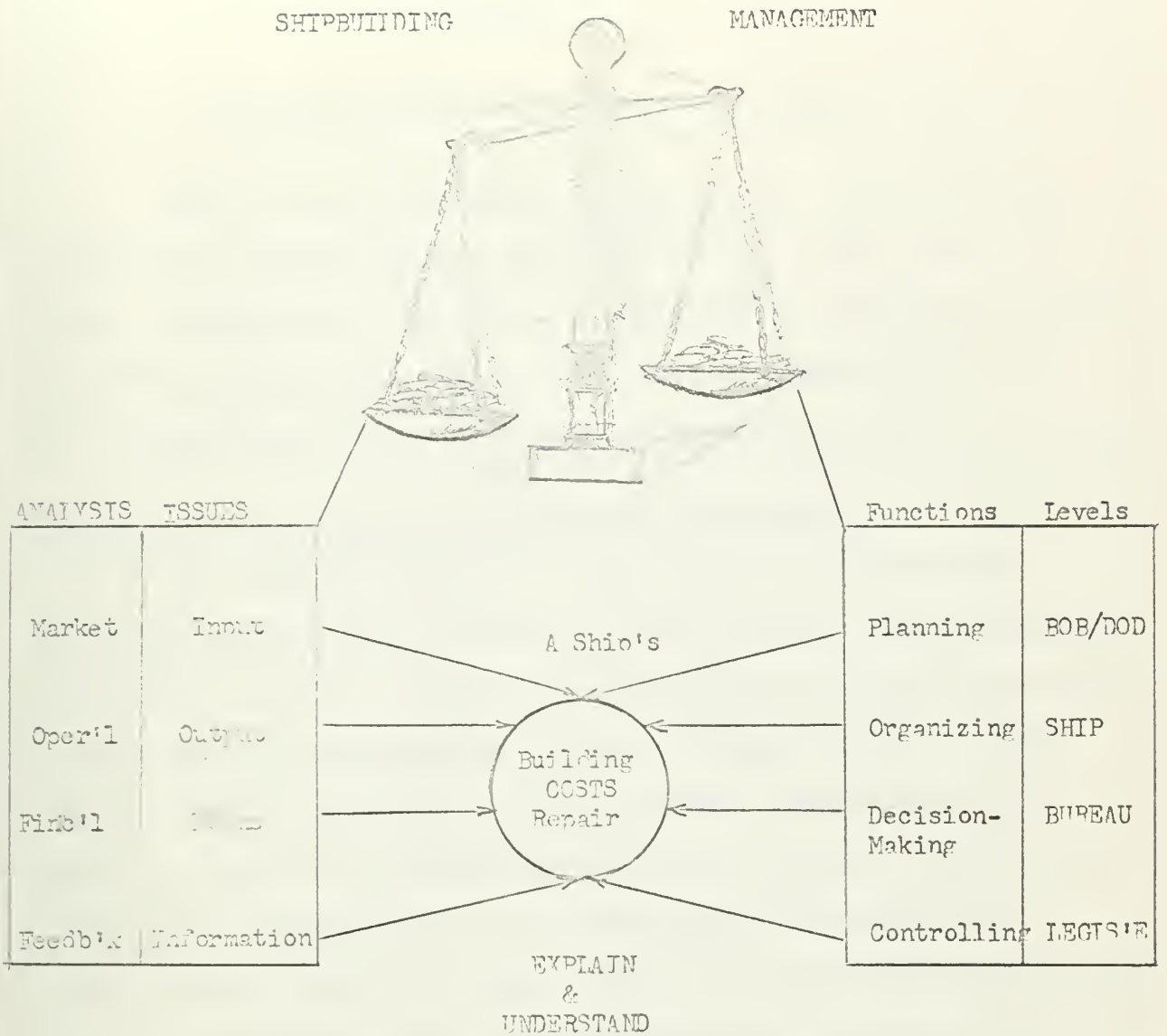
Figure 1--The DDG Class and the Destroyer, guided missile,
in the context of the U.S. BUDGET classification

NATIONAL SECURITY	Function
DEPARTMENT OF THE NAVY	Organization
PROCUREMENT	Object
SHIPBUILDING AND CONVERSION, NAVY	Appropriation
Other WARSHIPS	Budget Activity
BUREAU OF SHIPS FUNDS	Subhead
DDG CLASS	Budget project
A guided missile destroyer	Budget subproject

Source: Burkhead and U. S. Department of the Navy, Office of the Comptroller, NAVEXOS P-1355, Budget Digest, Fiscal Year 1965.
U. S. Department of Defense, Office of the Assistant Secretary of Defense, Comptroller U. S. Department of the Navy, Management of Procurement and Production Program for Shipbuilding and Conversion, December 1961.

the Department of Defense's Programming principles, the naval shipbuilding considerations and the laws relevant to methods of financing naval shipbuilding. It is recognized that the need to finance naval shipbuilding stems from the function of government that provides national security for its people, in a world of limited human and material resources. The goal of financing naval shipbuilding rests in efficient allocation and use of the people's financial resources.

Figure 2



CHAPTER II

CONTROLLING SHIPBUILDING EXPENDITURES

This chapter discusses the six means of controlling shipbuilding expenditures currently in use in the Bureau of Ships. Objectives, organizational structure, fund accounting, execution procedures, standard contracts, internal auditing and shipbuilding information systems are presented.

Methods of Controlling Shipbuilding Expenditures

The primary mission of the Bureau of Ships is to design, procure, build, convert, alter, repair and equip ships of the Navy, and is carried out both through contracting with private industry and through a shore establishment of about 110,000 employees. Contracting for ship construction with private industry is accomplished by the Bureau of Ships Headquarters in Washington, D. C. The Bureau of Ships shore establishment consists largely of naval shipyards, laboratories, naval supervision of the shipbuilding done at private shipyards, and various ship repair activities.

The basic organization of the Bureau of Ships is considered to be functional. The Bureau Chief has overall responsibility for the organization, and is aided by a Deputy Chief, six Assistant Chiefs, the Comptroller, the Director of Contracts and certain Staff special assistants. Under the

Assistant Chiefs, divisions are established on a functional basis. Programs cut across division lines.¹

The major divisions of the Assistant Chiefs (department unit heads) are as follows:

Plans, Programs, and Financial Management and Contracts

Research and Development

Design, Shipbuilding and Repairs

Technical Logistics

Field Activities

Nuclear Propulsion

The Assistant Chief for Design Shipbuilding and Repairs exercises basic responsibility for shipbuilding within the Bureau of Ships. He supervises the Design Division and the Ships Division, and is aided by a Shipbuilding Assistant, who heads a staff office which supervises, coordinates, and controls the shipbuilding fund execution. This office prepares shipbuilding costs estimates up to the point of the award of a contract. After this point the estimating process is turned over to the Ships Division, with the Shipbuilding Assistant acting as reviewer and coordinator. The Shipbuilding Assistant is known as the "Program Manager for Shipbuilding."

The Ships Division consists of seven ship branches, one for each major type of ship (e.g. destroyers, submarines). The ship branches act as system managers in that they coordinate

¹U. S. Department of the Navy, Bureau of Ships and Office of the Comptroller. Procurement and Production Program and Shipbuilding and Conversion (December, 1961), p. 5-2.

the action of other branches and divisions of the Bureau of Ships as well as the other Navy Bureaus on matters pertaining to the type of ships under their cognizance from the management and engineering viewpoint. For financial transactions relating to designated ships, the ship branches are known as "Project Managers." Procurement documents, with the exception of electronics production equipment contracts, either originate in or are cleared by the ship branches.

The Assistant Chief for Technical Logistics is responsible for providing the hull, machinery, electrical and electronic components and equipments (except for nuclear components) for the shipbuilding appropriations. He supervises four divisions, one functional and three covering broad commodity areas. The Technical Materials Division has the function of over-all material management.

The Bureau of Ships organization establishes the responsibility of each individual and the authority which he has. Its primary fundamental objective is the coordination of efforts of all so that they will be able to work together efficiently.

A pattern of reports and statistics must follow the Bureau of Ships organization structure so that information may be available for the use of top management. Resulting report data, which flows up the line, must not only reflect the result of what happened last month, last week or yesterday, but must be developed in such a manner as to provide the information needed by management to plan what should be done

next week, next month or next year. Consequently, it must be available promptly; it must be accurate and it must be presented in such form as to be of the utmost use. Hence, the need for a uniform accounting system throughout the Bureau's organization.

The control of shipbuilding funds within the Navy rests with the Bureau of Ships. The responsibility includes funds distribution, shipbuilding execution, and reporting for the appropriation as a whole.

The apportionment of funds is received by the Navy in a lump sum, generally for a full quarter's operation. Using as a basis the previous Bureau of Ships requests submitted as a part of the apportionment request, the Navy Comptroller allocates shipbuilding funds to the Bureau of Ships at the budget activity level.

The arrangement of budget activities used for allocation of funds by the Navy does not correspond identically with the arrangement used in the annual budget presentation to Congress. The reason for this is because congressional presentation is in summary form.

Upon receipt of the shipbuilding budget activity allocations from the Navy Comptroller, the Bureau of Ships distributes amounts for shipbuilding programs to the various subheads (one per program year), projects (one per ship type), subprojects (one per ship) and to accounts reflecting the basic split in project manager responsibilities, such as between electronics production equipments and other items. The split distribution is made by the Bureau's Budget Division

on advice from planning amounts stated on a Bureau of Ship form 4408. The responsibility for the control of funds within the Bureau of Ships is functionally assigned to the Bureau's Comptroller. The amounts shown on the Form 4408 are posted by the Accounting Division at the subhead, project and organizational breakdown level as "funds available." From then on, procurement documents may be processed against these amounts by the project managers and recorded by the Accounting Division.¹

Form 4408 is used as a device for maintaining shipbuilding dollar controls. No procurement exceeding the amounts on the form may be processed by the Accounting Division. Organizational controls are used at a level one step below the shipbuilding project to separate the electronics and non-electronics dollars. The present level of financial control matches the level of shipbuilding line items (the project or ship type) and the level of the two organizations administering the subheads programs, the Assistant Chief for Shipbuilding, and the Assistant Chief for Logistics.

The Ship Type Branches hold all of the shipbuilding funds except for equipment and electronics production equipment. All procurement documents chargeable to those dollars must be cleared through this office. The type branches are known as Project Managers for these dollars.

The Shipbuilding Assistant holds the dollars for equipment and is the project manager for them. The Shipbuilding

¹Ibid.

Assistant is also known as the Program Manager for all Bureau of Ships shipbuilding dollars.

The Financial Management Staff of the Logistics Division holds the dollars for electronic production equipment. The group acts as the Project Manager for the dollars.

There are four major prerequisites in carrying out the shipbuilding management game. These are: (1) authorization of the shipbuilding dollars by the Congress, (2) appropriation of the dollars, (3) apportionment of the dollars and (4) shipbuilding authorization by the President. Once these actions are completed, the Chief of the Bureau of Ships--in his role as the coordinator of shipbuilding and repairs for the Department of Defense and as head of the Bureau responsible for the shipbuilding appropriation--is assigned the responsibility for the successful accomplishment of naval shipbuilding.

The role of the Office of Naval Operations during the execution period is twofold: (1) to control ship characteristic changes through the Ship's Characteristics Board, and (2) to follow the progress of ships being built in order to plan for and direct the phasing of such new ships into the Fleet. The Deputy Chief of Naval Operations (Fleet Operations and Readiness) has the specific responsibility for phasing.

The day-to-day direction of shipbuilding work is performed by the Bureau of Ships in Washington. Overall program monitoring at the Bureau level is done by the Shipbuilding Assistant. Responsibility for completion of individual ships is vested in the seven Ship Type Branches in the Bureau

of Ships.

The inspection and administration of private shipbuilding contracts is performed by Navy Supervisors of Shipbuilding generally located at or near the shipyards.

The Bureau of Ships recommends the split of ship awards between private and naval shipyards. The Vinson-Trammell Act of 1934 (P. L. 73-135), however, provides for alternate awards of major combatant ships to public and private shipyards, unless the President, in directing prosecution of the shipbuilding program determines it to be in the public interest to make exceptions to this principle.

Design work for shipbuilding ranges all the way from a few exploratory plans in the early stages, through perhaps 15 separate plans in connection with the approved preliminary design, about 150 plans in connection with a completed contract design, and to 7,000 working plans. The design and accompanying specifications are normally completed prior to award of the ship contract. Plans and specifications are either prepared by the Bureau of Ships or contracted to a private design agent. These plans and specifications enable the prospective builder to comprehend the scope of the job and to make a bid on constructing the ship. The ship is actually built from the more detailed working plans prepared either by a shipbuilder or a private design agent.

An integral part of the pre-award planning process is the determination of what equipment is government furnished and what is contractor furnished. Usually, electronic equipment,

weapons, nuclear reactors, boilers, and turbines are government furnished. The reason is that this equipment is of a military nature subject to continual development and improvement.

Shortly before the award of a ship contract, the Shipbuilding Schedule Office prepares a "contract completion study." Essentially, this is a highly refined advance lead time study, and recommends the time to be specified in building the first ship of a class, including required shipment and procurement dates of key components, estimated shipyard work force, and required completion dates of key design tasks.

Awards to private shipbuilders are based on a Master Bidder's Mailing List maintained in the Bureau of Ships, which lists the firms qualified to build the various ship types. Invitations to bid are sent to firms responding affirmatively to a preliminary inquiry letter sent out to ascertain the shipbuilder's interest in bidding for a specific ship. Virtually all shipbuilding contracts are negotiated rather than advertised because of the large scope of work and great detail in plans and specifications.

The major types of contracts used are fixed-price escalation, fixed-price redeterminable, cost-plus-fixed-fee, and letter contracts.

Fixed-price contracts with escalation constitute the normal contracting method for ship construction. In terms of dollar measurement, 80% of all basic ship contracts are of this type. The escalation provision is generally used when a proposed contract will run over an extended period under

circumstances in which the stability of market and labor conditions is doubtful. Escalation payments are based on the labor and material indices agreed to in the contract. Under the terms of the standard contract clause, the contracting officer may deny escalation if he determines that the escalation adjustment is not required for the contractor to earn a fair and reasonable profit. Appeals from such decisions can go as high as the Armed Services Board of Contract Appeals.

Fixed-price redeterminable contracts are used when the specifications are not completely clear on certain points and the shipbuilder's bid seems to contain too many contingencies.

Cost-plus-fixed-fee contracts are limited to unusual prototype ships, such as the nuclear-powered guided missile cruiser.

Letter contracts are preliminary contractual instruments used to authorize immediate commencement of work. They are converted to and superseded by one of the other types of definitive contracts.

Control of the shipbuilding appropriation is accounted for in the Bureau of Ships Appropriation Control Ledger. This is established on an annual basis and reflects, at the appropriation level, the total dollars available for expenditures (new obligational authority plus unexpended balance), the amount apportioned by the Bureau of the Budget, the amount allocated by the Comptroller of the Navy, expenditures (disbursements), and the expended balance. A separate ledger is used to control appropriational reimbursements, and reflects

anticipated reimbursements, orders received, receivables, and collections. Posting documents consist of appropriation warrants, apportionments and allocations, accounts receivable reports, allotment expenditure reports, and disbursement, refund and reimbursement registers. An appropriation status report is prepared monthly from the accounts in the appropriation control ledger and the current month's trial balance of the subhead control ledger accounts.

The second level of controlling under the shipbuilding appropriation is at the subhead level. The accounts are maintained in a Subhead Control Ledger, which reflects the amount distributed to the subhead, allotments issued, commitments, obligations, expenditures, and the unexpended balance. The Subhead Ledger is subsidiary to the Shipbuilding Appropriation Control Ledger. Obligations recorded on the Subhead Ledger are liquidated by posting cash disbursements reported from Naval Comptroller Schedules Form 2025 or 2030.

Shipbuilding Information System

One of the important plans used in controlling shipbuilding expenditures is the informative system. In the Bureau of Ships there are 48 independent computer systems currently in use. Only three¹ of these are located at the Bureau's Headquarters and the other 45 are in operation in field activities such as the eleven Naval Shipyards or the offices

¹Department of the Navy, Bureau of Ships. Personal interview with Mr. William Issacs, October 23, 1964.

of the Supervisor of Shipbuilding Organizations at the private shipyards. One of the three, a large size IBM 7074, is Navy owned. The other two, medium-sized IBM 1460's are rented. A rough estimate of the total cost of all units utilized under bureau cognizance for management ADP applications (assuming \$300,000 for each computer) is about \$15,000,000. The three computers at headquarters are valued at approximately \$2,000,000.

The organization of the Bureau necessitates presenting the survey under two major areas, headquarters and the field agencies, for an overall general view of the shipbuilding information system.

ADP currently in effect in the Bureau of Ships are used in two major areas: Bureau headquarters, and Shipyards.

Bureau Headquarters: The three computers are used mainly in the accounting and stock control functions.¹ However, other interrelated functions are important to the overall bureau application. These include:

(1) Administrative.² Procedures in this general area include directives listings, personnel statistics, officer director, personnel time and leave, security check list and allotment accounting maintenance.

¹Department of the Navy, Bureau of Ships. Personal interview with Mr. J. Hayes, October 19, 1964.

²Department of the Navy, Bureau of Ships, Bureau Headquarters "Business Type" Data Processing Program, September 30, 1964.

(2) Research and Development. Data systems include Research, Development, Technical and Engineering planning, sum of fuel used and hours underway listings, water consumption records, RDT&E Operations records, and nuclear powered ships listings.

(3) Design, Shipbuilding and Fleet Maintenance. In this major function information in record form is maintained on listings of basic fleet/naval vessel registers, estimated cost to build/convert ships, bureau responsible material, estimated weights, power analysis, ship alteration programs, ships casualty reports, index listings, weight material requirements, and weight control systems.

(4) Technical Logistics. Data is presented in reports and listings on PERT (Program Evaluation Review Technique), Navy Standard Requisition and Issuing Procedures, electronic assembly library, hazard studies, milestone status, requisitions from other agencies, specifications and standards for BUSHIPS, contract status of specific material, allowance parts, electronic inventory reporting system, and coordinated ships allowance lists.

(5) Contracts. Procedures in this area are designed to record listings on supervisor of shipbuilding change orders, procurement reporting control, and contract bidders lists.

(6) Plans, programs, and financial management. Data systems are used to record listings on SCN Apportionment fiscal accounting reporting, personal services, average age of ships summaries of engineering data, cost information systems, and

material line item accounting.

Shipyards:¹ The 45 computers are used under the classification of the Management Information System. This usage provides shipyard management with information under three major areas: material, finance and production. A degree of standard shipyard reporting procedures has been established in these three broad functional areas at seven naval shipyards:

- (1) Portsmouth, N. H.
- (2) Boston, Mass.
- (3) Philadelphia, Pa.
- (4) Norfolk, Va.
- (5) Long Beach, Calif.
- (6) San Francisco, Calif.
- (7) Mare Island, Calif.

The areas of ADP procedures currently presented at these shipyards are as follows:

(1) Material management area. This area consists of two applications: Shop Stores and Commitment/Direct Material Inventory Control.

(a) Shop Stores (Internal Control Listings). In this application, a master field of Shop Stores items is maintained in conjunction with a technical description file. The master files with related transactions produce management reports such as shop stores catalogue, transaction ledger, transaction history, and an inventory trial balance.

¹Department of the Navy, Navy Department, Bureau of Ships. Cost Application and Budget Manual.

Transaction data is passed from this application to the commitment/direct material inventory control for development of accounts payable registers on shop stores receipts, and to the cost application for costing purposes.

(b) Commitment/Direct Material Inventory Control (External Control Listings). This use encompasses maintenance of master files representing Naval Industrial Fund Material and Services commitments and direct material inventory. These files serve the dual purpose of furnishing both physical and financial control (external) needs on a daily basis. Examples include status of material requisitions, material receipt with related accounts payable registers, material expenditures, and maintenance of daily financial balances of outstanding commitments and direct material inventory. Transactions are passed from this application to the cost application for centralized financial reporting, summary control and cost distribution.

(2) Financial Management Area. This area includes the subroutine, Cost Accounting, which is the focal point for validation of all labor and material transactions with subsequent master file updating and processing to produce a complete financial report. Budget compilation and reporting is also a part of this subroutine. Transaction data is dispersed for use in production, planning, control and design applications. In a similar manner, the consolidated cost/Production Planning and Control master file is updated.

(3) Production management area. This area consists of the following subareas: Production and Planning, and workload

forecasting and design.

(a) Production and Planning. This application consists of extracting and summarizing data from the updated cost accounting Production Planning and Control master file, which provides reports for standard usage, work center performance, direct labor analysis, schedule performance, and force distribution. Essentially this is a feedback for future analysis.

(b) Workload forecasting. This procedure represents long range workload forecast and shop workload forecast based on bureau estimates of ship overhaul or conversion. Manpower requirements evolve from this process.

(c) Design. This procedure consists of providing unforeseen changes to original Bureau of Ships drawings which are made necessary by special projects, ship alterations, standard work items, and testing techniques.

The functions which the Bureau calls Field Activities and Inspector General represent a grey overlapping of subroutines between the Bureau of Ships and the particular shipyard. These include items such as alteration/overhaul budget forecast, overhaul schedule programs, alteration cost records, and ship repair costs.

The general plans for the future call for an integrated automatic data processing system under the control of the Bureau's Data Systems Policy Group chaired by the Assistant Chief of the Bureau for administration. It is anticipated that the ADP in the many field activities would be linked with

ADP at the Bureau in specified critical information areas. This would provide a macro-management information center on all aspects of shipbuilding and repair functions, which is the mission of the Bureau of Ships.

Chapter 1: Introduction to the study of the history of the world.
 The world is a complex and ever-changing entity, and its history is a story of constant evolution.
 This chapter will explore the origins of the world and the factors that have shaped its development.
 We will look at the physical world, the human world, and the world of ideas.

Chapter 2: The physical world.
 The physical world is the foundation of everything we know. It is the world of matter and energy, of space and time.
 This chapter will explore the physical world from the beginning of time to the present day.
 We will look at the formation of the Earth, the evolution of life, and the forces that shape the planet.

Chapter 3: The human world.
 The human world is the world of people, of culture, of society, and of politics.
 This chapter will explore the human world from the beginning of time to the present day.
 We will look at the evolution of man, the development of culture, and the forces that shape society.

Chapter 4: The world of ideas.
 The world of ideas is the world of thought, of philosophy, of science, and of art.
 This chapter will explore the world of ideas from the beginning of time to the present day.
 We will look at the development of thought, the evolution of philosophy, and the forces that shape science and art.

Chapter 5: The future of the world.
 The future of the world is a topic of great interest and concern. It is a topic that has fascinated people for centuries.
 This chapter will explore the future of the world from the beginning of time to the present day.
 We will look at the forces that shape the future, the challenges we face, and the hopes we have for the world.

CHAPTER III

SHIPBUILDING AND REPAIR COSTS

This chapter deals with a financial interpretation and analysis of the total cost of the DDG Class of guided-missile destroyers from birth to death; this includes contract shipbuilder costs, change order costs, government furnished material costs and repair costs. Its purpose is to show the importance of management's recognizing and maintaining the craftsmanship and quality of work at the shipbuilding yard.

The chapter examines four areas:

- (1) Definitions of cost categories
- (2) Ship and shipyard cost schedules and graphs
- (3) Determination of costs and cost differences
- (4) General and future findings

The research stems from interviews with officers and managing personnel in the Department of the Navy. The figures represent those recorded in the source documents of the respective organizations having accounting responsibility for their maintenance. In no way are these figures to be construed as being absolute, as their significance lies in their relativity to the purpose of this analysis.

The concept of cost requires qualification. In the course of developing any cost information, it is necessary

to make a large number of subjective decisions as to which of various methods will be used in accumulating, measuring, and weighing the variables. In each case there may be several methods which are in general use. There exists no uniform concept of cost for all purposes (even though there is discernible agreement on certain broad principles), and almost every organization's methods or procedures for developing costs are unique. A particular system of costing represents the cost philosophy or concept of the organization in which it is used and applied under particular circumstances for a particular purpose. Thus, the validity and utility of any cost must be considered in terms of the original purpose of the cost system which produced it and the purpose for which the cost is now to be used.¹

Definitions of Cost Categories

The contract cost is the amount in dollars which the government pays the shipbuilder for building the ship according to its requirements, which are expressed in writings and drawings and are called the ship's general and special specifications. These specifications serve as a measurement tool used by naval inspectors to determine whether the shipbuilder has met the requirements. Qualifications to the specifications are needed from the time the contract is signed until the time the ship is delivered to the fleet. In the first ship of a

¹ Donald J. Fennelly, "Judging Mince Pies," Harvard Business Review (November-December, 1964), p. 81.

class or a development ship these qualifications reflect a refined operating-research-development stage. The result is a substantial increase in the final contract cost of the lead ship to the government as contrasted with the remaining ships of the class.

Change order costs are the amount of dollars the government pays the shipbuilder/yard to account for technological and craftsmanship innovations relating to a ship's improvements between the contract date price and the delivery date cost. It is recognized that the nature and complexity of shipbuilding necessitates this margin of building safety, above the original contract price. The problem with change orders is determining a target figure that is realistic as to empirical data and at the same time gives the manager a measure of craftsmanship competence and/or quality of work.

Government furnished material costs are paid out for material that government agencies control, exclusive of shipbuilding organizations, and usually center on weaponry material. The shipbuilder has responsibility to install this equipment, and the cost of government material installation is technically included in the contract price. The problems associated with installation of government furnished material usually are resolved in the development costs of the leader ship of the class, contract cost, and minor problems between individual ships are resolved in change order costs between the contract date and the delivery date.

Repair costs are the dollars paid by the government

to a shipyard for work performed on the ship, after it has been delivered to the Navy. It includes maintenance on installed equipment, technological and craftsmanship innovations in weaponry as well as other shipboard equipment, and the ship overall beyond the ship's company and ship's tender capabilities. Ship tenders are naval ships specifically designated as repair facilities, and basically perform repair work using naval military personnel as contrasted with naval shipyards or private shipyards, which use civilian personnel.

The delivery cost of a ship is equal to the contract cost plus the change order cost plus the government furnished material cost.

Classified ship costs represent the economically significant capital expenditure costs to the government exclusive of military civilian and military Navy personnel and represent the government's investment in a particular ship. A knowledge of these costs can provide a basis for determining ten or fifteen years after the commissioning date of a ship whether it is more efficient to incorporate major weaponry and shipbuilding innovations into it or to run it out with its present capabilities knowing what future costs can be expected to keep it operational within defined capabilities.

TABLE 2

SHIP DELIVERY COST SCHEDULE

In Millions of \$

Ship	Contract	Change Orders	GPM	Total
USS CHARLES F. ADAMS (DDG-2)	31.1	0.9	18.5	50.5 ✓
USS JOHN KING (DDG-3)	20.1	0.6	18.5	39.2 ✓
USS LAWRENCE (DDG-4)	22.7	0.9	18.5	42.1 ✓
USS CLAUDE V. RICKETTS (DDG-5)	21.4	0.6	18.5	40.5 ✓
USS BARNEY (DDG-6)	21.5	0.6	18.5	40.6 ✓
USS HENRY B. WILSON (DDG-7)	21.2	0.9	18.5	40.6 ✓
USS LYNDE McCORMICK (DDG-8)	21.8	0.6	18.5	40.9 ✓
USS TOWERS (DDG-9)	24.5	0.9	18.5	43.9 ✓
USS SAMPSON (DDG-10)	20.6	0.6	18.5	39.7 ✓
USS SELLERS (DDG-11)	19.2	0.6	18.5	38.3 ✓
USS ROBISON (DDG-12)	20.6	0.6	18.5	39.7 ✓
USS HOEL (DDG-13)	22.8	0.6	18.5	41.9 ✓
USS BUCHANAN (DDG-14)	21.9	0.6	18.5	41.0 ✓
USS BERKELEY (DDG-15)	21.6	0.6	18.5	40.7 ✓
USS JOSEPH STRAUSS (DDG-16)	21.1	0.6	18.5	40.2
USS CONYNHAM (DDG-17)	20.5	0.6	18.5	39.6
USS SEMMES (DDG-18)	22.9	0.9	18.5	42.0 ✓
USS TATTNALL (DDG-19)	20.7	0.6	18.5	39.8
USS GOLDSBOROUGH (DDG-20)	18.1	0.6	18.5	37.2 ✓
USS COCHRANE (DDG-21)	18.6	0.6	18.5	37.7
USS BENJAMIN STODDERT (DDG-22)	18.2	0.6	18.5	37.3

Source: U. S. Government Appropriation Number 001611 for Period
Ending June 30, 1964. Ship's Cost Report.

TABLE 3

DDG CLASS CONTRACT PLUS CHANGE ORDER COST SCHEDULE

	Actual Contract Cost + Change Orders Paid to Shipyard
USS CHARLES F. ADAMS (DDG-2)	\$32 Millions
USS JOHN KING (DDG-3)	20.7
USS LAWRENCE (DDG-4)	23.6
USS BIDDLE-RICKETTS (DDG-5)	22.0
USS BARNEY (DDG-6)	22.1
USS HENRY B. WILSON (DDG-7)	22.1
USS LYNDE McCORMICK (DDG-8)	22.4
USS TOWERS (DDG-9)	25.4
USS SAMPSON (DDG-10)	21.2
USS SELLERS (DDG-11)	19.8
USS ROBISON (DDG-12)	21.2
USS HOEL (DDG-13)	23.4
USS BUCHANAN (DDG-14)	22.5
USS BERKELEY (DDG-15)	22.2
USS JOSEPH STRAUSS (DDG-16)	21.7
USS CONYNHAM (DDG-17)	21.1
USS SEMMES (DDG-18)	23.5
USS TATTNALL (DDG-19)	21.3
USS GOLDSBOROUGH (DDG-20)	18.7
USS COCHRANE (DDG-21)	19.2
USS BENJAMIN STODDERT (DDG-22)	18.8

Source: Department of the Navy, Bureau of Ships Accounts,
Appropriation 001611 for Period Ending June 30, 1964.

Shipyard A		Shipyard B		Shipyard C	
DDG-2	\$32	DDG-7	\$22.1	DDG-4	\$23.6
3	20.7	8	22.4	5	22.0
10	21.2	12	21.2	6	22.1
11	19.8	13	23.4	15	22.2
				16	21.7
				17	21.1
<hr/>		<hr/>		<hr/>	
\$ /ship <u>20.6</u>		<u>22.3</u>		<u>22.1</u>	
<hr/>		<hr/>		<hr/>	
<u>Shipyard D</u>		<u>Shipyard E</u>			
DDG-9	\$25.4	DDG-18	\$23.5		
14	22.5	19	21.3		
20	18.7				
21	19.2				
22	18.8				
<hr/>		<hr/>			
<u>20.9</u>		<u>22.4</u>			

Year in which Dollars were funded/appropriated schedule

Shipyard A		Shipyard B		Shipyard C		Shipyard D		Shipyard E	
	No.		No.		No.		No.		No. ships
1957	(2)	1957	(2)	1957	(3)	1957	(1)	1959	(2)
1958	(2)	1958	(2)	1958	(3)	1958	(1)		
						1960	(3)		
	<u>4</u>		<u>4</u>		<u>6</u>		<u>5</u>		<u>2</u> TOTAL SHIPS/ shipyard

TABLE 5

A SCHEDULE OF REPAIR COSTS BY SHIP GROUPED UNDER
THE BUILDING SHIPYARD

Shipyard A		Shipyard B			
DDG-3	\$528,791	DDG-7	\$484,000		
10	751,605	8	534,000		
11	696,211	12	665,000		
		13			
Shipyard C		Shipyard D		Shipyard E	
DDG-4	\$985,000	DDG-9	\$774,000	DDG-18	\$
5		14	885,000	19	
6		20			
15		21			
16		22			
17					

Source: U. S. Atlantic Fleet, Cruiser-Destroyer Force Letter of 1 February 1965 from Captain D. C. McNeill, SC, USN, addressed to researcher.

U. S. Pacific Fleet, Cruiser-Destroyer Force Letter of 29 October 1964 from Force Material Officer Gustav F. Swainson, Jr. and addressed to researcher.

Figure 3
The Order of Delivery Cost in Millions
of Dollars per Ship
SHIPYARD, SHIP, HULL
D 3 20

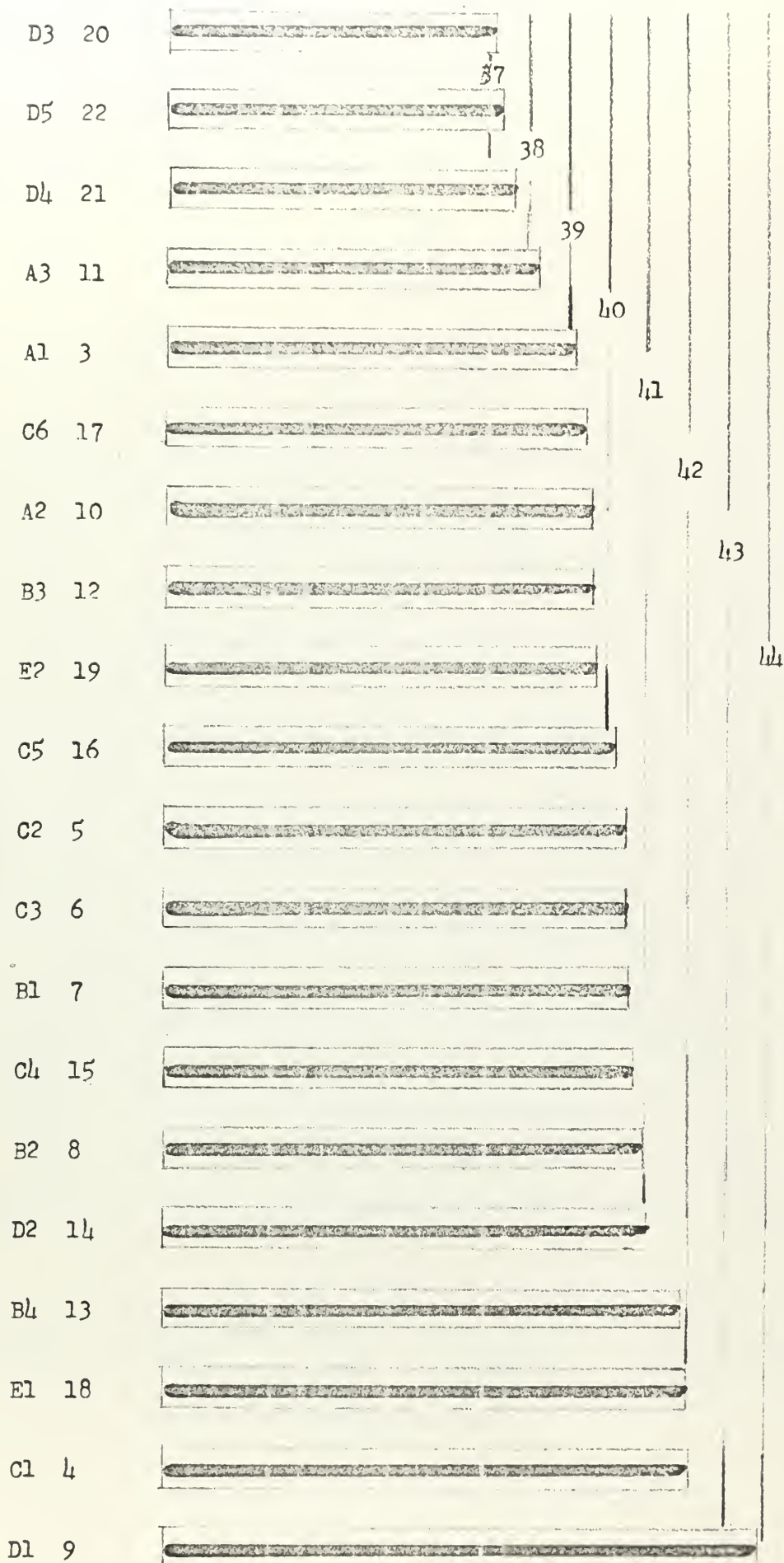


Figure 4

DELIVERY COST DISTRIBUTION CURVE * DDG CLASS

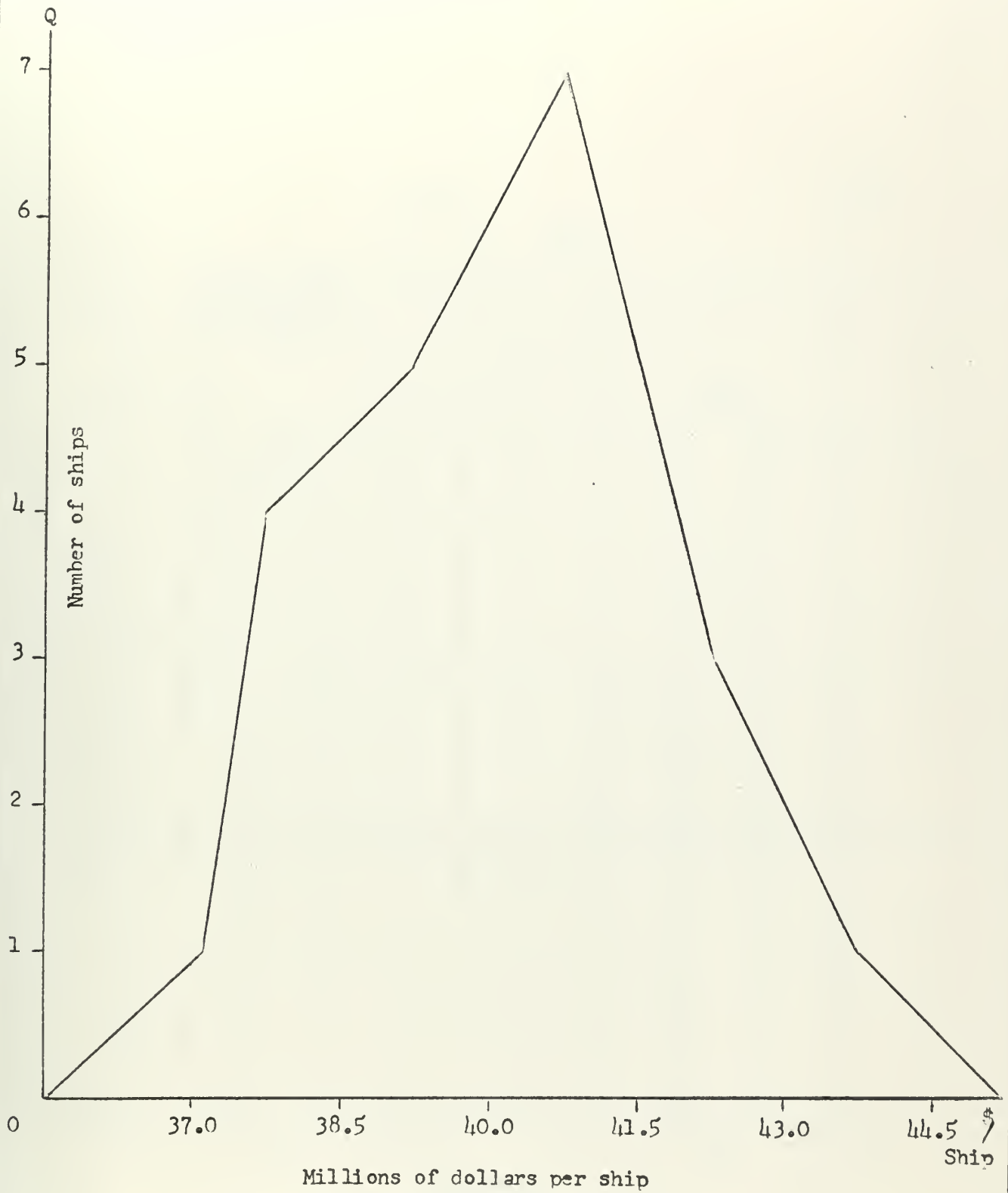


Figure 5

COMPARISON OF SHIPYARDS AVERAGE COST PER SHIP

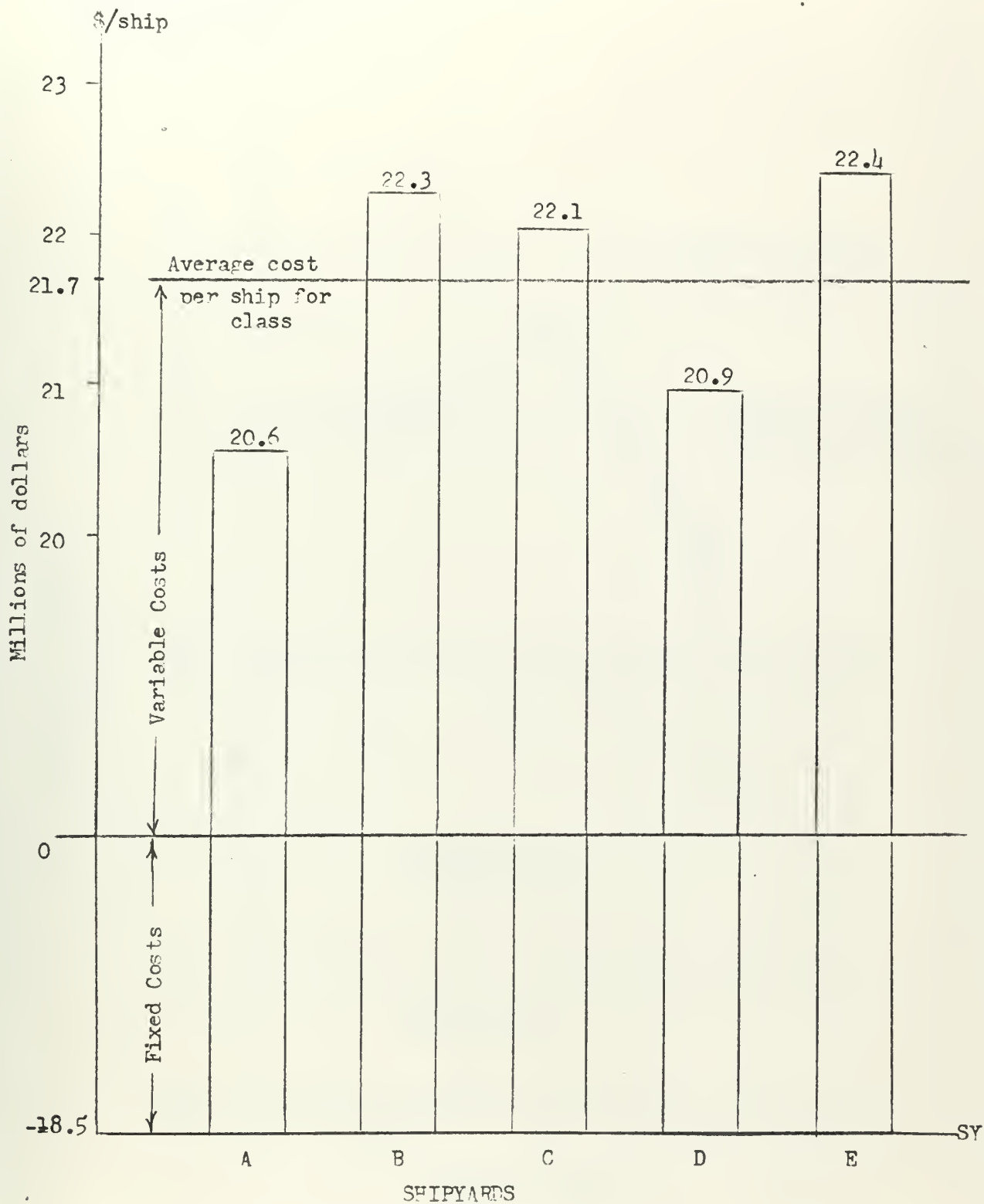


Figure 6

SHIPYARD A's DELIVERY COST PER SHIP

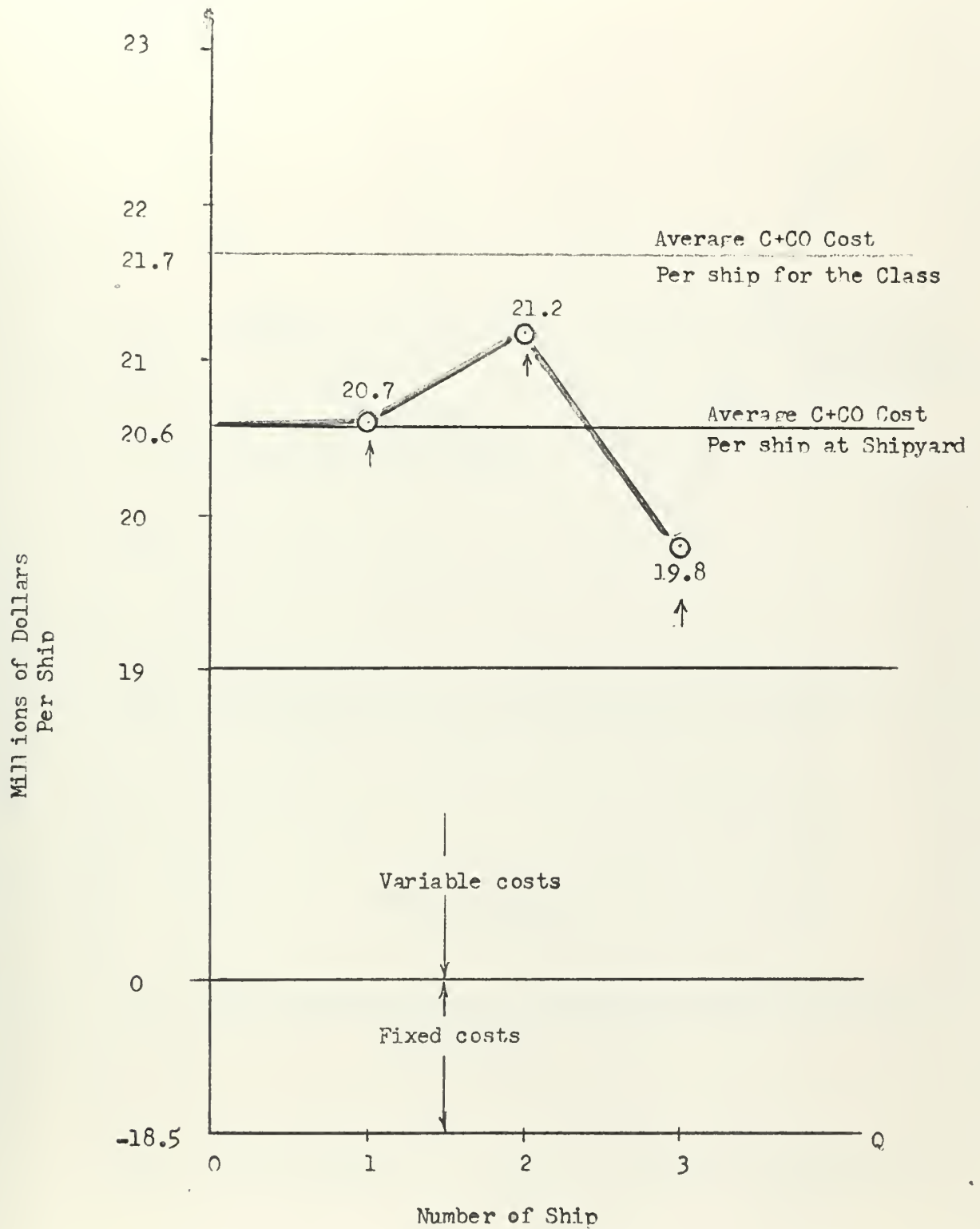


Figure 7

SHIPYARD B's DELIVERY COST PER SHIP

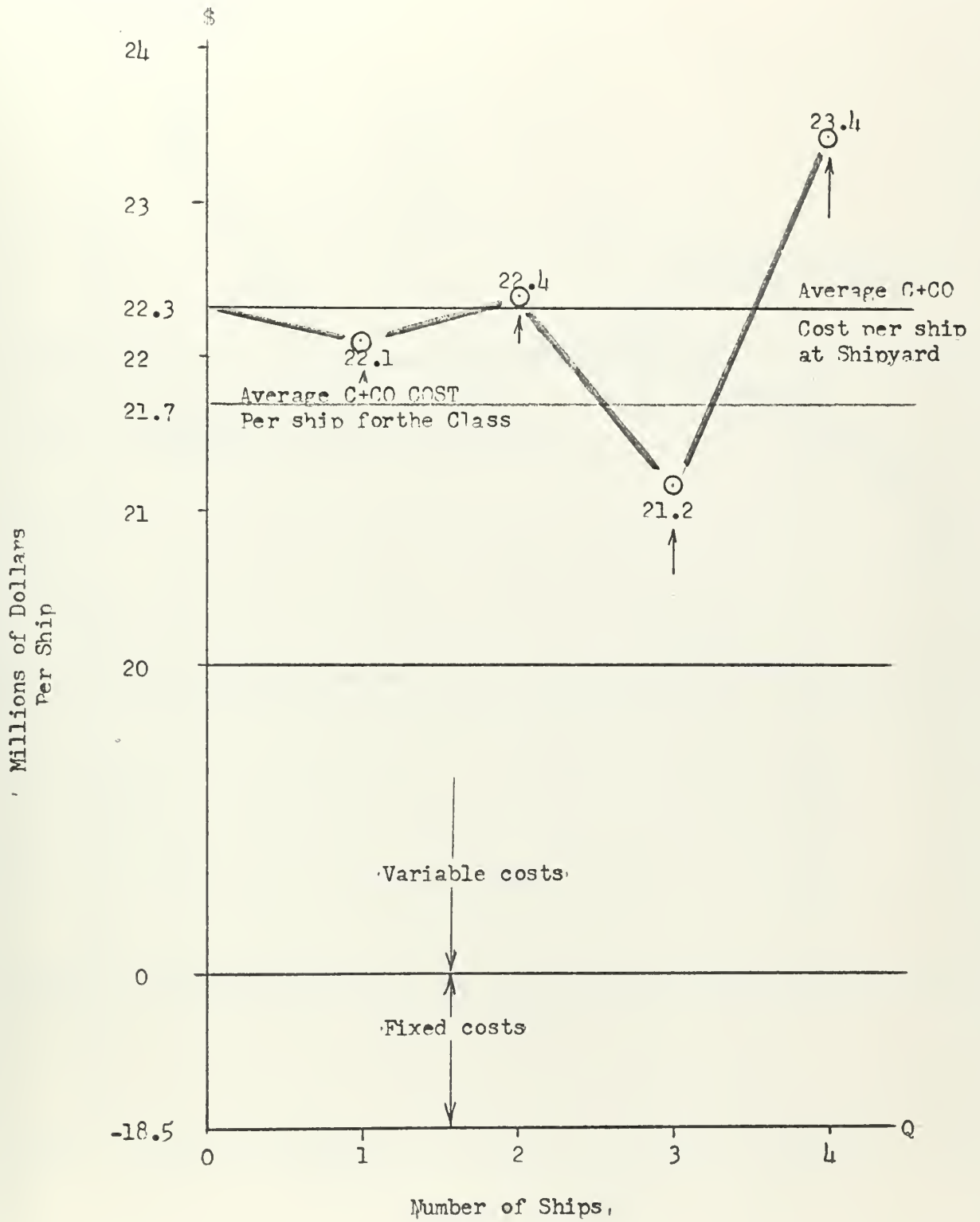
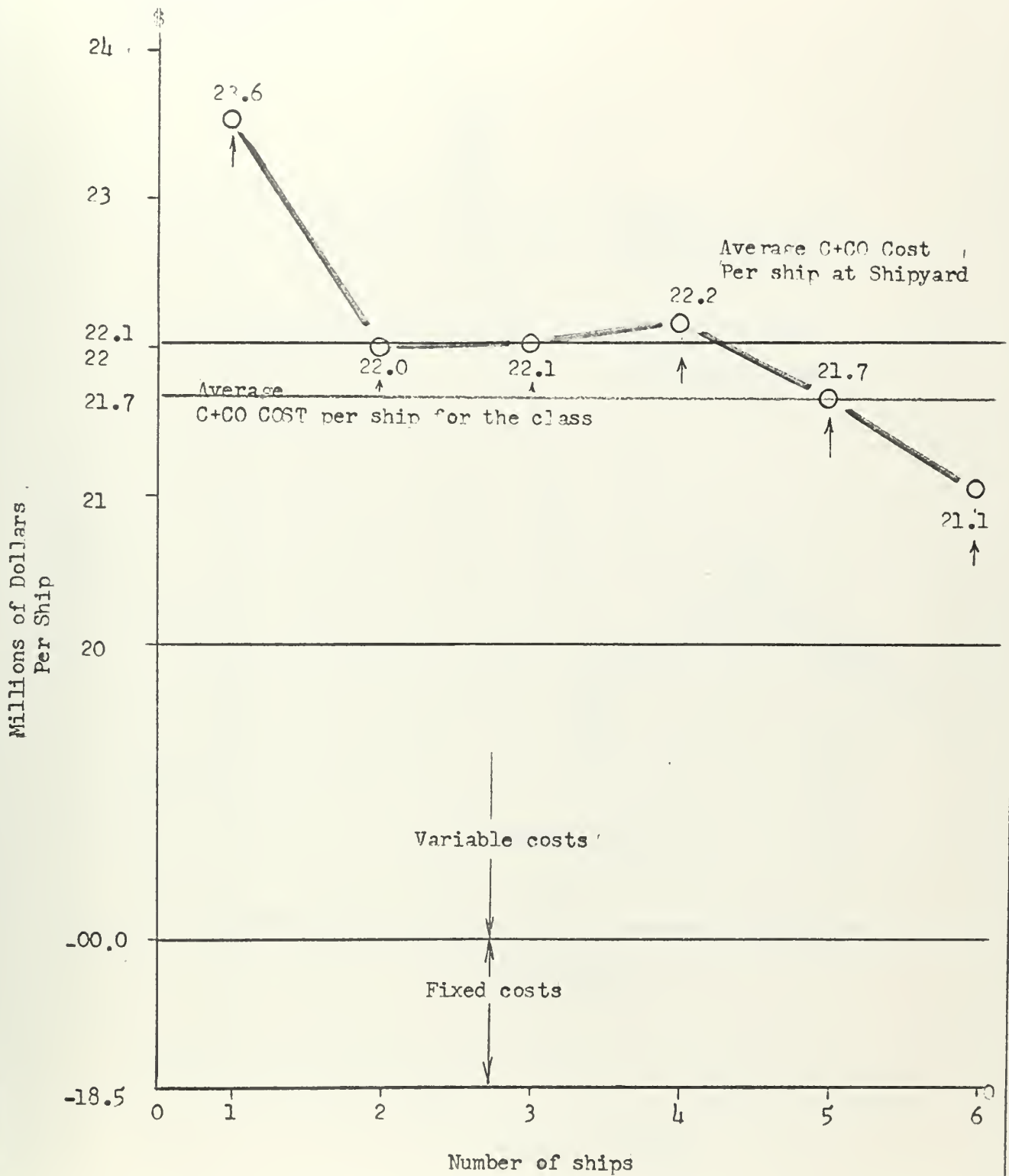


Figure 8

SHIPYARD C's DELIVERY COST PER SHIP



52
Figure 9

Millions of Dollars
Per Ship

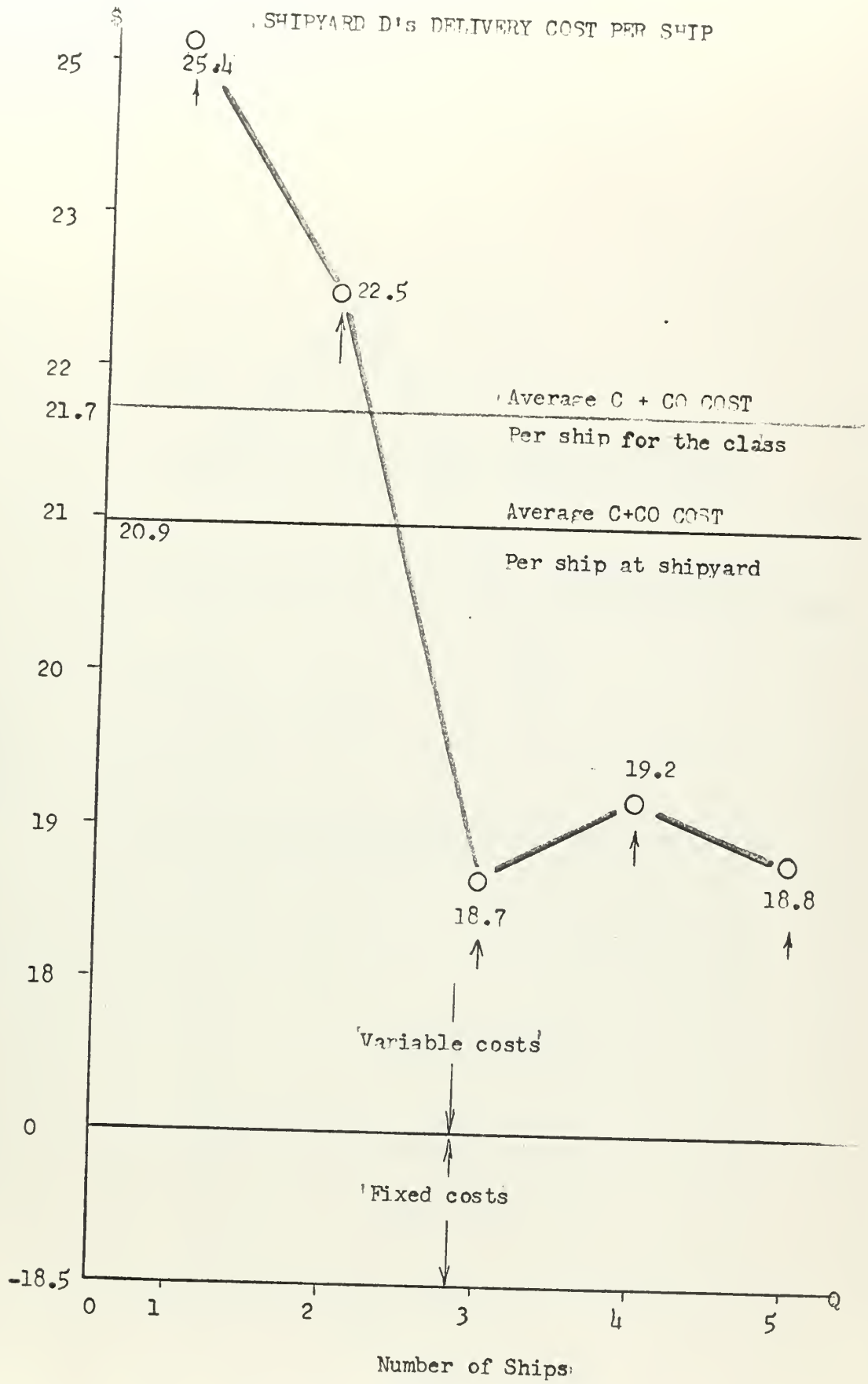


Figure 10

SHIPYARD E's DELIVERY COST PER SHIP

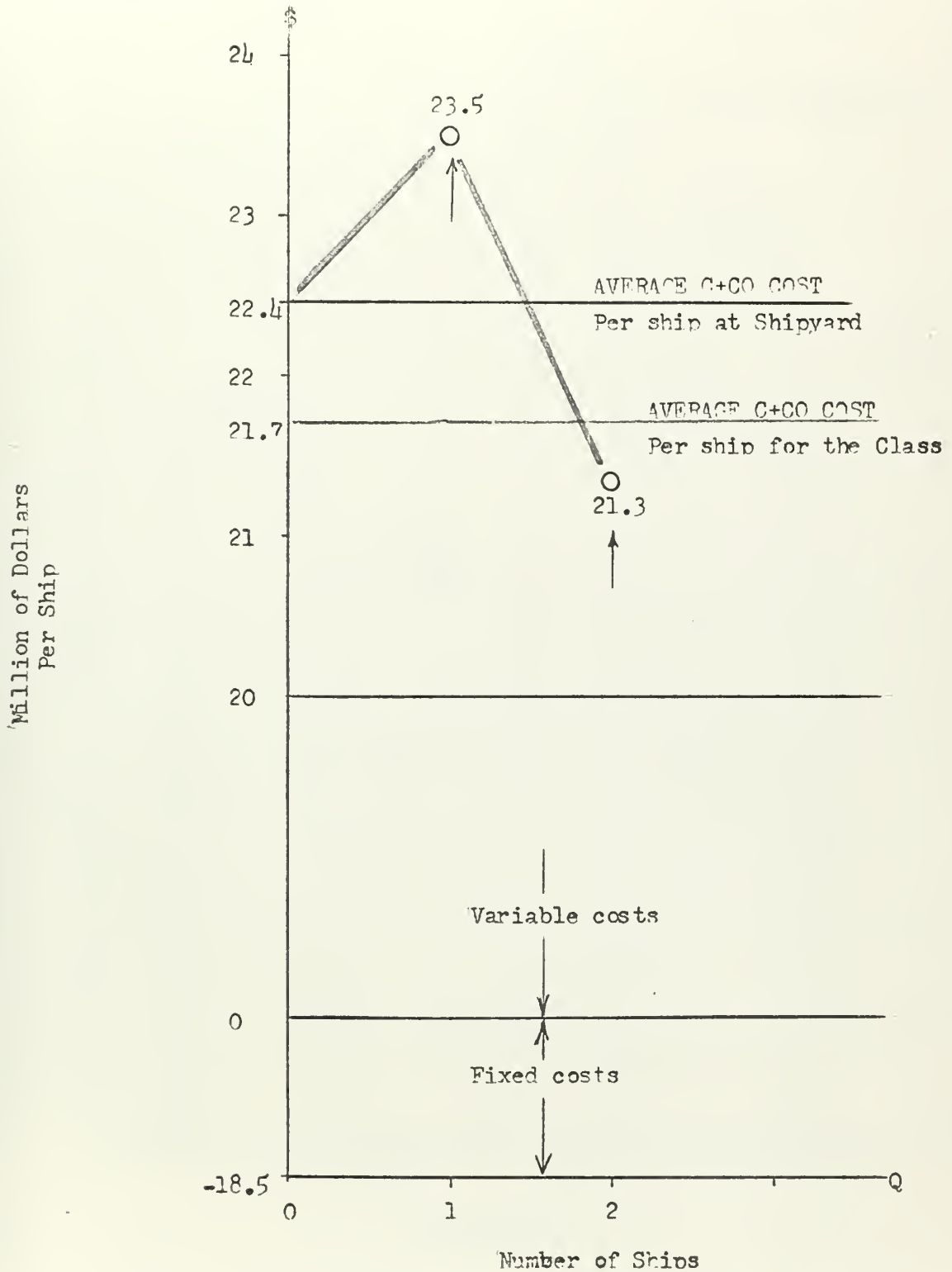
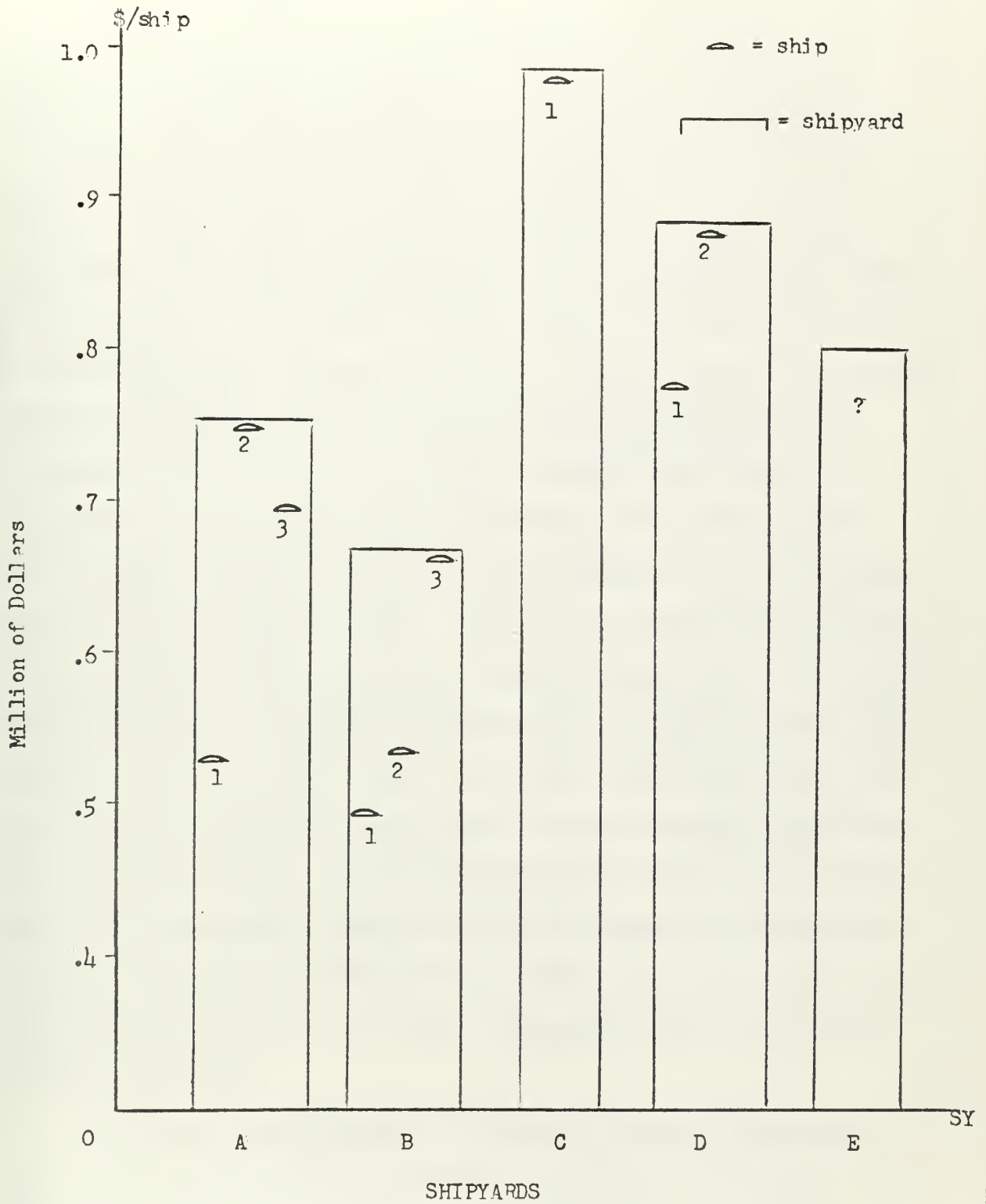


Figure 11

REPAIR COSTS BY SHIP GROUPED UNDER BUILDING SHIPYARD



Determination of Costs

Change order costs for each ship of the class are determined by using the averaging method and the heuristic method (as this method assumes or postulates what remains to be proven, the change order cost is treated "as if" it was solved). There appears to be justification in establishing two figures for each shipyard, one for the original ship built at that yard and the other on the remaining ships built there. It is assumed that a degree of error exists between the general blueprint drawings and the actual physical integration of all parts of the ship. It is also assumed that technical innovation and craftsmanship improvements will necessitate minor changes between the date of the contract and the completion of the building process. It is also assumed that because of the learning curve theory (a worker learns as he works; and the more often he repeats an operation, the more efficient he becomes, with the result that the direct labor input per unit declines) the first ship will have a higher change order cost than succeeding ones. After examining the total change order costs for the twenty ships on page 44 it appears workable to establish \$300,000 and \$200,000 per year per ship as the change order cost included in the total contractor cost of the ship to the government.

The cost of government furnished material for each ship in a class can be determined by averaging the total government furnished material cost. Since the shipbuilding yard has no control over these purchases and since one supplier

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usually provides the complete set of material for the entire class, it can be assumed that the price for government furnished material for each ship is a constant amount. It can be seen from the chart on page 42 that the cost of the DDG missile destroyers, the cost is \$18.5 million per ship. The total for the twenty ships is \$370 million dollars.

The delivery cost to the government of these twenty ships of the DDG class exclusive of the lead development ship is as follows:

Government furnished material	\$370 million
Contract cost	420 million
Change orders	13 million
	<u>\$803 million</u>
Delivery cost per ship	\$40.25 million

The average costs per ship under the cost categories are:

<u>Contract</u>	<u>Change orders</u>	<u>GFM</u>	<u>Delivery</u>	<u>C&CO</u>
\$21.0	0.9/0.6	18.5	\$40.2/40.1	\$21.7

It can be seen that government furnished material and change order costs can be treated as fixed costs in any performance analysis of the quality of work done on a given ship at a given shipyard.

Cost Differences

The significance of cost differences in building ships may be explained superficially by the time factor by claiming that work performed one year has a different dollar value than work performed in subsequent years. Analyses such as the

consumer or Federal Reserve Board Industrial Production index are used to support this analogy. However a look at the dates at which contracts were budgeted appears to nullify this idea. With the exception of Shipyard (E) it can be noted that the average cost plus change order per shipyard for a class decreased as compared with the average C&CO cost for the class in contracts budgeted in later years. This implies that efficiency is increasing at a faster rate in most shipyards than the purchasing power of the dollar is increasing.

This cost difference may be explained by examining the geography of the country. There is a tendency for shipyards located in or near urbanized areas of one million or more population to have higher average cost and change order per ship, per shipyard, as compared with the average C&CO cost of the class. Shipyards B and C on page 44 are in this category and seem to bear this out. Since a worker with qualified craftsman skills will be sought by more than one industry in a large urbanized area, the shipbuilder in a less populated area has to offer higher wages to attract a man with the same skills. Although there is an increase in the supply of skilled workers available to a shipyard in a highly populous area, this is not always in proportion to the total population of the area, so the shipyard often has to choose between lesser skilled craftsmen or higher contracted prices.

A look at the chart on page 45 and Figure 11 shows a difference between the repair costs at shipyards A and B as compared with shipyards C and D, and also a difference between

the repair costs among or between ships built at a given shipyard.

One explanation for the differences between repair costs of ships built at different yards appears to lie in the quality of workmanship performed at each yard. The difference between repair costs of ships built at the same yard also appears to lie in the quality of workmanship performed. Why? It is not because of having a higher cost associated with its original building price. The assumption here is that more dollars means more work incorporated into the whole ship when delivered to the government, thereby making future repair costs less. However, if a check is made between ships numbers 3 and 10, and 7 and 8 and 12, it is obvious that this assumption is not true in this case.

The quality of work at a building shipyard is constantly being tested by naval inspectors to ascertain that the minimum general specification requirements are being met by the shipbuilder. However, the inspector cannot be expected to note the daily and hourly craftsmanship that goes into building a ship. This quality can be measured only by the ability of the ship to maintain a naval seaworthy condition for its expected life.

A projection into the expected cost of repairs during the life of the ship leads into a discussion of how much of a target cost per year would be fair to use in measuring work done by the shipbuilding yard and at the same time allow for technological and craftsmanship innovation during the next

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twenty years.

A partial solution of this question requires an examination of change order costs and repair costs taken separately and together. Why not use the empirical data established for change orders and the same for repair costs to arrive at a percentage that could relate to the contractor's cost? Since the criteria established for change orders and repair costs are a result of the same cause, technological and craftsmanship innovation, then this appears in line. Since the quality of work at the yard is expressed to some degree in the contractor's price, then it is logical to relate this triad of factors.

The data on change orders indicates that one per cent per year of the average contract price for the class appears justifiable. Applying this same percentage to repair costs, the indication is that this one per cent per year of the average contract price for the class is in order. If this is the case, the next step is to ask, "What compensation can be given to the building yard for those ships that have less repair costs than this figure?" and "What penalty can be charged against the building yard for those ships that endure repair costs above this figure?" These questions are beyond this thesis, and would certainly add to the overall insurance that the quality of workmanship into the ship was not being overlooked as the key management issue in cost-analysis of a guided missile destroyer from birth to death.

Shipboard Organization and Repair Costs

One of the issues influencing repair costs is the way a ship is operated and organized. This area in itself is a field of separate study which is beyond the scope of this paper's central theme; however, for purposes of a vertical follow through on repair costs it should be recognized that good shipboard organization has as its ultimate goal that of being an effective fighting unit. Efficient use and allocation of men and equipment aboard ship aid in achieving this goal.

It is assumed that good shipboard organization principles and considerations are not only important to efficient shipboard operations but also to aid in reducing ship repair costs. Good shipboard organization builds into every supervisory job decentralized authority and responsibility for both short and long range shipboard repair on shipboard equipment.

There are two types of shipboard organizations, each with its characteristics and influence on ship repair costs. Every shipboard organization grows from one to the other. Every ship that grows and expands successfully develops in successive stages from a highly functional to a divisionalized type of organization. It accomplishes at the same time a move from a predominantly centralized authority to a decentralized one.

The functional shipboard organization is effective in reducing ship repair costs because it requires only one group of weapon facilities, one engineering function and one supply function. Hence, both capital and to a degree administrative expenses relating to shipbuilding management at the Bureau of

Ships level as mentioned in Chapter II are held to a minimum, ultimately benefitting planning for financing naval shipbuilding.

The divisionalized organization structure on a ship breaks the functional organization into relatively small, self contained administrative units and aids the supervision of ship repair costs. With proper decentralization, each such division is capable of measuring its own repair costs, both against other ships and inside the ship against other divisions. Divisionalization is a shipboard organizational means of retaining the advantages of the small, functional type of organization, while minimizing the disadvantages that come with increased size, diversification, delivery capacity complexity, cost limits and training.

Findings of Cost Figure

Some of the findings resulting from a financial analysis and interpretation of the costs of naval ships are as follows:

1. No two shipyards build a naval ship at the same average delivery price to the government. The main reason can be explained in terms of geography and urbanization and now this relates to supply and cost of shipbuilding skills.

(See Table 2).

2. No two ships within a given shipyard cost the government the same price. This can be partially explained in terms of the learning curve theory of efficiency. (See Figure 9).

3. The cost of change orders during the ship's building period can be estimated at 1% per year of the contract bid price

of the ship, provided it is not the first ship of the class built at that particular shipyard. If the latter is the case, 1 1/2% should be estimated. The support of these figures lies partially in empirical data and partially in shipbuilding manufacturing logic. (See Table 2).

4. The contract cost of the lead development ship (first ship of a class) costs approximately 50% more than the average cost for the class. This infers a form of research and development cost which is characteristic of the shipbuilding naval construction industry.

5. The shipyard that builds the first ship of a class can build the remaining ships at that yard at approximately 5% below the average contract cost for the class, assuming that other shipyards are building these same class ships. To explain this requires consideration of three factors: First, the problem associated with construction on the development have imparted a greater degree of mutual understanding between the government and the craftsman as to what is best for the ship according to the principles of naval construction and to what the government wants in the way of price and general specifications. Second, according to the learning curve theory the efficiency of the craftsman should progress at a faster rate because of the interplay between worker participation in the decision-making process and shipyard management and government administration. Third, probably the most important factor is the level of skill inherent within the worker himself. (See Table 2).

6. Government furnished material is approximately

constant for all ships of a class. It can be treated as a fixed cost when evaluating the performance of work between shipyards and between ships. The main reasoning behind treating GPM as a fixed cost is because the purchase and quality of material in this equipment is beyond the control of the building shipyard. (See Table 2).

7. The time factor in relationship to price fluctuations in dollar value and purchasing power from the time when the contract was awarded does not appear to be a major factor in explaining the discrepancies between the average C&CO cost of the class and a particular ship. This is explained by the assumption that the rate of efficiency by workers on succeeding ships or later contract year ships is faster than the increases in consumer and industrial production indexes. (See Table 4).

8. The geographical factor offers a significant explanation of the differences in average cost per ship between shipyards. It is based on the principle that the supply of skilled craftsmen does not increase in proportion to the increase in total population of an area. Consequently, the disparity in wage scales in highly urbanized locations as compared with rural locations affects shipyard management decision-making as to the quality of skill that can be purchased at a given price. This situation has as its result, the quality of work obtained in a given ship. (See Table 5).

9. There appears to be a competitive advantage built up for future year bidding if a shipyard can get at least one contract to build a ship above the price it costs the other

shipyards in the same year. Comparing shipyard D with other shipyards supports this generalization. This can be explained in terms of reserve building by the shipyard concerned, which was probably awarded the contract on the basis of political and social considerations rather than economic considerations. However, the shipyard is able to compete economically in future contracts as a result of this reserve buildup. (See Table 4 and Figure 9).

10. Shipyard quality workmanship and future repair costs can be related in evaluating the former and forecasting the latter. This idea is supported by comparing repair costs of ships built at different shipyards, by examining the nature of the present inspecting policy, by recognizing the effect of the sea, and by accounting for the importance of the quality of craftsmanship at the building shipyard. (See Table 5 and Figure 11).

11. Repair costs of ships vary on the average from 1% per year after delivery date to 1.25% and 1.50% per year of the average contract price. This difference can be explained and attributed to the quality of workmanship performed at the building shipyard. (Table 5 and Figure 11).

12. A guide for future repair costs can be determined not only for ships built at a particular yard, but also for each ship of a class. This requires a profile pattern on each ship using the 1, 1 1/4, and 1 1/2% repair figures. This evaluation yardstick could serve as a valuable tool in aiding management within government to determine not only what present

day costs can be expected to build ships of a particular class at a particular shipyard, but also what repair costs are likely to develop and what quality of work has gone into a particular ship. (See Figures 6, 10 and Table 4).

Summary

The implication of the difference between the average contract plus change order cost of a ship for a class and the average C&CO cost of a ship for each shipyard has broad policy considerations in the area of the management of naval ship construction and repair costs. Granted such considerations as proficiency of craftsmen, wage scale differentials, and development costs, the major element in explaining the meaning of this difference of costs rests in the government's specifications of what it requires in its naval ships.

In order to permit the government to state what it wants, the lead or initial development ship of a class should have a lead time of proper duration. The time should be such as to allow subsequent ships of a class to be built at different yards with the benefits or refinements recognized in the development ship construction process.

The complexity and nature of naval shipbuilding and repair are such that change order costs will be required to correct or install technological and craftsmanship innovations. A percentage figure of the average contract price for the class or one of the goal target contract price can be established. It appears that 1% per year of this average or target price should be the government's objective. Requests for dollars

above this figure should indicate that the craftsmanship at a shipyard requires increased supervision by management through better selection of craftsmen or improved training or both.

The development shipyard for a class of ship has a responsibility to ensure that the best naval shipbuilding and architectural principles are given adequate consideration. It can fulfill this responsibility only if its craftsmen are effective and highly qualified and only if its management is efficient. These considerations are ingredients that the government decision-making process has to weigh in selecting a qualified shipyard among the shipbuilding bidders.

It can be seen that when the government decision-maker tries to interpret and analyze naval shipbuilding and repair costs he is faced with a complex and dynamic problem. He must know not only the significance of geography, time, urbanization, wage scales, and price indexes factors, but also the importance of the qualifications of the development shipyard, change order necessities, the skills of the workers, and the commitment of government to the original bidders for the class of ships to be built.

It is recognized that the need for deciding what shipyard will build a ship or what the repair cost of a ship should be emerges from the government function of providing national security for the country, which has unlimited military demands in a country of limited resources. Therefore, proper management to provide efficient use and allocation of these resources is the order of business of the government policy and

decision-maker.

The performance evaluation of the shipbuilding yard does not end when the contracted ship is delivered to the government. It lasts throughout the life of that ship by noting the relationship of any future repair costs to the shipyard in which it was built.

CHAPTER IV

CONCLUSIONS

The nature of shipbuilding management is such that there is no alternative to a careful description of the issues and a total management view of the workings of the legislative and executive Naval Shipbuilding mechanism. Not only does a shipbuilding manager need to know the nature of shipbuilding and repair costs, but he must also have a total approach on management issues and functions to explain, analyze and interpret the naval shipbuilding cost problem.

The need for naval shipbuilding in the United States stems from the government's function of providing national security with limited human and material resources, and necessitates as the goal of naval shipbuilding management, the efficient use and allocation of these resources.

The opening chapter of this paper dealt with the problem of planning for financing naval ship building and discussed the complexity and magnitude of naval shipbuilding through the interplay of various organizations involved in the budgeting process. The shipbuilding appropriation was identified as part of the Defense Department's Program Structure and the source of money for naval shipbuilding was explained.

Chapter II on management dealt with the problem of

controlling shipbuilding expenditures through a properly designed information reporting system. However, complete control through the Bureau of Ships is changing and may cause a shift to a centralized control by the Department of Defense.

Chapter III on the nature of building and repair costs of the guided missile destroyer dealt with the problem of evaluating, recognizing, and maintaining shipbuilding craftsmanship through statistical decision-making. An examination of the four types of costs--contract, change orders, government furnished material, and repair--makes possible a comprehension of the amount of government investment in naval shipbuilding and repair costs. Shipyards were compared, measured, and explained in terms of time, geography and quality of work influence on costs. The interpretation of this financial data on naval ships leads to the finding that an improvement in managing naval shipbuilding costs can be achieved through recognizing the role of government, more effective use of the concept and practice of the development ship and development shipyard qualifications.

The performance evaluation of a shipbuilding yard does not end when the contracted ship is delivered to the government. Further studies are needed to develop an incentive system through repair cost comparisons whereby a shipbuilding yard is compensated according to the quality of its workmanship. Since the matter of value or performance is not readily apparent in naval shipbuilding management, a manager is forced to rely on the less reliable factors of building yard reputation and

a presumption that the quality of hidden elements is equal to those on the surface, which can readily be evaluated by naval inspectors.

The principles of organizing for the efficient and effective utilization of a ship to achieve the objectives of providing national security efficiently and effectively is mentioned in Chapter III. An introduction to the point that organization considerations are important to efficient shipboard operations and ultimately affect ship repair costs is made.

In developing an effective management approach to naval shipbuilding, it is necessary for a manager to have a thorough understanding of the problems of a ship's lifetime building and repair costs. The crux in naval shipbuilding costs lies in the skills and conceptions of its managers. Change and improvement are the laws of life, and those managers who do not concern themselves with management effectiveness will impede the progress of efficient naval shipbuilding.

APPENDIX

ORIGINAL COMMANDING OFFICERS OF THE DDG CLASS

<u>Ship</u>	<u>Commanding Officer</u>
USS CHARLES F. ADAMS (DDG-2)	CDR W. R. MUNROE
USS JOHN KING (DDG 3)	CDR A. M. SACKETT
USS LAWRENCE (DDG 4)	CDR T. W. WALSH
USS BIDDLE (DDG 5)	CDR P. ROTH
USS BARNEY (DDG 6)	CDR J. J. DOAK, JR.
USS HENRY B WILSON (DDG 7)	CDR L. D. CANEY
USS LYNDE McCORMICK (DDG 8)	CDR E. S. CORNWALL
USS TOWERS (DDG 9)	CDR L. D. CUMMINS
USS SAMPSON (DDG 10)	CDR F. I. ISEN
USS SELLERS (DDG 11)	CDR W. R. JOHNSON
USS ROBISON (DDG 12)	CDR D. V. COX
USS HOEL (DDG 13)	CDR A. W. SLIFER
USS BUCHANAN (DDG 14)	CDR D. A. WEBSTER
USS BERKELEY (DDG 15)	CDR W. E. HARPER, JR.
USS JOSEPH STRAUSS (DDG 16)	CDR W. M. A. GREENE
USS CONYNHAM (DDG 17)	CDR E. P. SMITH
USS SEMMES (DDG 18)	CDR R. G. ALEXANDER
USS TATTNALL (DDG 19)	CDR W. F. REGAN
USS GOLDSBOROUGH (DDG 20)	CDR C. D. ALLEN, JR.
USS COCHRANE (DDG 21)	CDR F. W. BENSON, JR.
USS BENJAMIN STODDERT (DDG 22)	CDR W. M. MEGINNIS

Source: Department of the Navy, Naval History Section.

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THE JOURNAL

At the meeting of the Board of Directors held on the 15th day of January, 1900, the following resolution was adopted:

Resolved, That the Board of Directors do hereby authorize the President to execute any and all contracts and agreements that may be necessary for the carrying out of the purposes of the Corporation.

Witness my hand and the seal of the Corporation this 15th day of January, 1900.

Attest: Secretary of the Corporation.

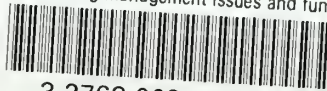
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